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Illustrated with Engravings.

BY WILLIAM NICHOLSON.

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PREFACE.

THE Authors of Original Papers in the present Vo- R. L. Edgworth, Esq.; J. G.; Mr. J. Sadler; J. Horsburgh, Esq.; R. B.; Mr. Charles Sylvester; Jonathan Stokes, M. D.; Rev. Johnson Grant, A.B.; Mr. J. Bennett; J. E. Conant, Esq.; Dr. Oersted; Mr. William Skrimshire, Jun.; S. Taylor, Esq.; A Correspondent.

Of Foreign Works, Professor Ritter; Messrs. Desormes and Clement; M. Vauquelin; A. Laugier; Professor Proust; Klaproth; Robiquet; Dispan.

And of English Memoirs abridged or extracted, C. Hatchett, Esq. F. R. S.; W. H. Wollaston, M. D. Sec. R. S.; Count Rumford, F.R.S.; Mr. W. Wallis Mason; Mr. Gilbert Gilpin; Mr. Thomas Parker; J. C. Curwen, Esq. M. P.; A. Carlisle, Esq. F. R. S. F.L.S.; S. A. Bardsley, M. D.; W. Herschell, LL. D. F.R.S.; Mr. John Mayow; Mr. W. Smith.

Of the Engravings the Subjects are, 1. The Furnaces and Apparatus at present used for refining Lead. By John Sadler. 2. An Odometer, for measuring the Distance run by a Carriage. By R. L. Edgworth, Esq. 3. 4. Figures to illustrate the Propagation of Electricity. By Dr. Oersted. 5. Diagram for describing the Wheels and Pallets of Graham's Escapement for Clocks. By Mr. Bennett. 6. An Escapement of Thiout. 7. Machine for facilitating the Work of Shoemakers. 8. An improved Crane. By Mr. Gilbert. 9. Method of using the common Chain in Pullies to greater Advantage than Ropes. 10. A Drawing, representing the Structure and explaining the Motion of Fishes. By A. Carlisle, Esq. F. R. S. 11. 12. Diagrams to exhibit the proper Motion of the Sun. By W. Herschell, LL. D. F.R.S. 13. A new portable Blow-pipe. By W. H. Wollaston, M. D. Sec. R. S. 14. Plan of Six Acres of Water Meadow, as improved by Mr. William Smith. 15. Improvement in the Striking Part of Clocks. By Mr. Ward. 16. A Machine for cutting the Edges of Books. By Mr. Hawkins. 17. Machine for the transfer of Boats through the Locks of Canals with the least possible consumption of Water.

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SUPPLEMENT.

A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND

THE ARTS.

SEPTEMBER, 1806.

ARTICLE I.

The Process for refining Lead, as practised in England. In a Letter from Mr. JOHN SADLER.

MY DEAR SIR,

CITZ. DUHAMEL, in his Memoir on the Refining of Lead in the large way, has given a sketch of the process used in England; if you think the following more detailed description will be acceptable to the readers of the Philosophical Journal, it is at your service.

Duhamel on lead works.

The object of refining lead is not merely on account of the silver it contains, but to procure it as free as possible from the other metals with which it is usually alloyed, and to procure litharge. The silver is only an object so far as it helps to pay the expense of refining.

Object of refining lead.

The lead produced at the smelting hearths or furnaces in England is never perfectly pure; it is always alloyed with a portion of silver, and most commonly with one or most of the following metals; viz. zinc, antimony, copper, and arsenic; which render it unfit for some of the purposes to which lead is applied.

Usual impurities of English lead besides silver.

It is refined by vitrification and reduction.

The operation of refining is founded on the facility with which lead is oxidated when exposed to heat in contact with atmospheric air, and the peculiar properties the oxides of lead possess; being easily fused, and in that state oxidating and combining with most of the metals; gold, silver, and platina excepted.

upon a cupel in a reverberatory furnace.

The lead to be refined is exposed to the action of heat and air upon a *cupel* or *test*, composed of a mixture of bone and fern ashes in a reverbatory furnace; the description of which, with the different manipulations, are as follows:

Description of the furnace for refining lead.

The refining furnace is composed of good solid masonry, bound together with iron bolts. It differs very little in its construction from the common reverbatory furnace, except the bottom, which is perforated to receive the test or cupel.

Fig. 1. Plate I. is a perspective view of the furnace with its iron work; *a* the teazing hole, *b* aperture by which the test is supplied with lead, *c* an arch or dome over the feeding hole, communicating with the furnace stack by a flue, *d* area or space where the test is taken in and out the furnace, *e e* two strong iron bars to support the test when in its place, *f* cast-iron pot set in masonry, the flue passing into the stack of the furnace, *g* the stack, *p* the ash pit, *q* an iron bar to slide the ladle on when feeding the test.

Fig. 2. a perpendicular section of the furnace shewing the test *i*, supported in its place under the opening of the bottom of the furnace by the two wedges *r r*; *k* aperture for the nozzle of the bellows, *s* fire bar resting on the bearers.

Fig. 3. plan of the interior of the furnace; *l* part of the bellows, *h h* flues from the body of the furnace to the stack.

The same letters in the different plans are meant to denote the same parts.

Plate II. Fig. 1. plan of the iron frame into which the mixture of bone and fern ashes is rammed to form the test. This frame is something larger than the elliptical hole in the bottom of the furnace.

Figs. 2 and 3. plan and section of the test; *m* the part which

which contains the lead to be refined, *n* breast of the test, *o o* small gutters or channels through which the litharge flows, *p* a semi-eliptical hole for the litharge to fall through from the gutters upon the area of the refinery.

These drawings and references will be sufficient to make the description of the furnace, &c. clearly understood.

Of the Test or Cupel.

A good test is of the first importance in refining; the method of constructing one I shall endeavour to point out. Six parts of well burnt bone ashes and 1 part of good fern ashes are to be well mixed, sifted through a sieve (the spaces in which are about $\frac{1}{8}$ of an inch square), and moistened to about the same degree the founders use their sand. The iron frame is to be laid on the floor and made steady, with wedges under its rim; about two inches in thickness of the ashes are to be equally spread over the bottom, and with an iron beater, such as used by the founders, equally rammed between the cross bars; the frame is to be again filled and rammed all over, beginning at the circumference and working spiral ways until finished in the centre, the filling and ramming to be repeated until the frame is completely full; an excavation to contain the lead is made as expressed in the plan, with a sharp spade about 5 inches square, the edges dressed with a long-bladed knife; a semi-eliptical hole, as at *p*, is to be cut through the breast. Having proceeded so far, the test is to be turned on its side and dressed from all superfluous ashes adhering to the bottom, taking care that none shall be left flush with the bottom of the frame or cross bars, otherwise in fixing the test to its situation at the bottom of the furnace it would be liable to be bulged.

The test is made of 6 parts bone and 1 fern ashes.

Fixing the Test in its situation.

The rim of the test is now to be plastered with clay or moistened ashes, placed upon the supporting cross bars, and fixed with wedges firmly against the bottom of the furnace, the breast next to the feeding hole.

Manner of fixing the test.

A gentle fire may now be lighted, and gradually increased until the test be red hot. When it ceases to emit steam from the under side it is sufficiently dry.

Lead previously melted in the iron pot *f* is ladled into the

Manipulation by which the

litharge is removed from the charge of fused lead, put into the test, &c.

the test until the hollow part be nearly filled, the operator closes the feeding aperture, and increases the heat of the furnace until the surface of the lead is well covered with litharge; he then removes the door from the feeding hole, and with an iron rod, which has one end bent down at right angles about 3 inches and made flat or chissel-shaped, scrapes the small gutter or channel *o* until the litharge just flows into it, the blast from a pair of double bellows is then directed from the back part over the surface of the test, the litharge is urged forward, and flows from the gutter upon the floor of the refinery; the operation now goes forward, gradually adding lead as the escape of litharge makes necessary, until the gutter is so worn down that the test does not contain more than an inch in depth of lead, the blast is then taken off, the gutter filled up with moistened ashes, and a fresh one made on the other side the breast; the test is again filled, though not so full as at first, and the operation carried on until this gutter also is worn down and the test contain from about 50 to 70 lbs. of alloy. This quantity is run into an iron pot, and set by until a sufficient number of pieces have been collected to make it worth while to take off a plate of pure silver from them.

Alloy left behind.

The quantity of alloy left in the working off each test must depend in a great measure upon the quantity of silver it by estimation is supposed to contain. A sufficient quantity of lead should always be left in the alloy to make it fuse easily in the iron pot.

Some litharge soaks into the test.

When the test is removed from the furnace and broken up, the litharge will be found to have penetrated to an inconsiderable but equal depth in the ashes; that part not impregnated with litharge may be pulverised, mixed with fresh ashes, and again used for another test.

The silver is refined by oxiding the lead it still contains.

The operation of taking off the silver pure differs in no respect from the foregoing, only more care is observed in the working, not to suffer the escape of any metallic particles with the litharge, as that would occasion considerable waste of silver. As the process advances, and the proportion of silver to lead increases, the litharge assumes a darker colour, a greater heat becomes necessary, and at last the brightening takes place; the interior

 of

of the furnace, which during the whole of the process had been very obscure and misty, clears up. When the operator observes the surface of the silver to be free from litharge, he removes the blast of the bellows, and suffers the furnace to cool gradually; as the silver cools many protuberances arise on the surface, and fluid silver is ejected from them with considerable force, which falling again on the plate spots it very fantastically with small globules.

The brightening.

Silver ejected from the mass as it cools.

The latter portions of litharge bring over a considerable quantity of silver with them; this is generally reduced by itself and again refined.

The last portions of litharge contain silver.

The litharge as it falls upon the floor of the refinery is occasionally removed; it is in clots at first, but after a short time as it cools it falls for the most part like slacked lime, and appears in the brilliant scales it is met with in commerce: if it is intended as an article for sale, nothing more is necessary than to sift it from the clots which have not fallen and pack it in barrels.

The litharge flakes in cooling.

If, on the contrary, it is intended to be manufactured into pure lead, it is placed in a reverbatory furnace, mixed with clean small-coal, and exposed to a heat just sufficient to fuse the litharge. The metal as it is reduced flows through an aperture into an iron pot, and is cast into pigs for sale. During the reducing, care is taken to keep the whole surface of the litharge in the furnace covered with small-coal.

It is reduced by keeping it covered with small-coal at a moderate heat.

In some smelt works, instead of a reverbatory furnace for reducing, a blast furnace is made ufe of, on account of the greater produce, but the lead so reduced is never so pure as that made in the wind furnace. The oxides of the metals, which require a greater heat to reduce than the lead, are in the blast furnace generally reduced with it.

The reduction is best performed in the wind furnace.

The volatile oxides, as zinc, antimony, and arsenic, are mostly carried off by evaporation during refining; a considerable portion of the oxide of lead itself is carried off by evaporation, making the interior of the furnace so misty and obscure that a person unused to refining cannot see more than a few inches into it.

Volatile oxides.

A considerable portion of these oxides are driven by the

carried up the chimney.

the blast of the bellows through the feeding aperture, and would be dissipated in the refining-house, to the great injury of the workmen's healths; to prevent their ill effects the arch or dome over the feeding hole is erected to carry the fume into the stack of the furnace.

II.

Facts and Observations relating to the Winds, Waves, and other Phenomena by which the Surface of the Sea is affected. In a Letter from James Horsburgh, Esq.

To Mr. NICHOLSON.

Sir,

On the surface of the sea.

FROM reading in your Journal Vol. 12th. the account of the Seiches of the Lake of Geneva, I have been induced to send to you a few remarks relative to the surface of the sea, which are more particularly applicable to the Indian and Chinese Seas, where these observations were made.—

The smooth regular waves of a steady breeze are augumented by the rise of a low cloud though the breeze is diminished.

When a steady breeze of wind has continued to blow for any length of time, with a clear sky, or small clouds high in the atmosphere, the waves are generally regular and smooth, gliding in the direction of the wind; particularly when there is no current:—At such times, if a dense cloud is generated, and is low in the atmosphere when passing over the observer, the strength of the regular breeze is decreased, and the waves appear to be agitated by the cloud whilst it passes over them; their summits being more elevated and turbulent:—but no sooner has the dense cloud passed the zenith of the observer, than the breeze resumes its former strength, and the waves glide along smooth as before.

It seems as if those clouds had a direct action on the surface.

When many of these dense clouds are generated, and follow the course of the prevailing wind, in succession, the waves become turbulent and irregular, particularly when these clouds are near the surface of the sea, accompanied by showers of rain: this has frequently been observed in the Indian Seas, and often inclined me to think these low dense clouds had some affinity with the surface of the sea.

The

The effects proceeding from these dense clouds during their passage over the zenith, are the opposite to those experienced from a regular squall :—for this generally first makes its appearance by a small arched cloud, either rising from the horizon, or formed at a small distance above it; which rises gradually until near the zenith.

These effects are opposite to those of a squall

When the preceding clouds of the arch approach the zenith, the strength of the squall commences, and continues strong during the passage of the clouds over it; which is the reverse of what has been noticed as the result proceeding from dense clouds generated at high altitudes.—Currents or ripplings on the surface of the sea, seem to have an affinity with the wind.—Where tides run strong, in the entrance of great rivers and other places, the strength of the wind is often observed to be modified by the tide; blowing strong on the flood, and moderate on the ebb, when the direction of the wind is into the rivers, or nearly in the line of the flood tide.

Effects of the squall.

Currents and tides affect the wind.

The following peculiarity of a sudden variation in the strength of the wind, has frequently been observed in low latitudes.—In settled weather, when a brisk and regular wind is experienced in deep water, if there are any shoal banks or coral flats of considerable extent, the strength of the wind is often perceived to be much less on these banks or flats, than in the deep water; more particularly if eddies or ripplings, occasioned by tide or currents prevail on the banks at the time.—I have often observed in getting on the edge of one of such banks, that the strength of the regular breeze instantly abated; but resumed its regular force on departing from the verge of the bank into deep water :—this has been experienced repeatedly; and I have found a ship hardly manageable from a deficiency of wind on the verge of a bank with shoal water on it; when at a small distance from it in deep water, some of the light sails were obliged to be taken in, the regular breeze over the surface of the deep water, prevailing so strong.

Upon banks or flats the wind is suddenly and considerably less than on the deep water.

In several parts of the Indian Seas, particularly to the eastward of the Nicobar Islands, between Achen Head and Junkseylon, very strong ripplings prevail during the south-west monsoon.—When these ripplings are very high and numerous, there is seldom any current experienced;

Very strong ripplings in the Indian Sea, with temporary diminution of wind.

ced ; which appears singular, for they are (I believe) generally supposed to be the effect of currents.

These ripplings extend in long narrow ridges, with smooth spaces between them of considerable extent:—they are alarming to strangers in the night, from the noise occasioned by the broken water.—The collision of the water in these ridges, produces breakers so high, that at times it would be dangerous to risk a boat amongst them, although the weather was serene.—They move with considerable velocity: when they pass a ship, a decrease of the strength of the wind accompanies them ; a trembling motion is given to the vessel by the great collision of the broken water, and frequently some spray is thrown on the deck.—The ridges are seldom more than a few minutes in passing ; the wind then resumes its former strength, which continues regular until another ridge assails the ship.—Probably these must proceed from the south-west monsoon blowing from the ocean, round Achen Head, into the entrance of Malacca Straits ; but it is singular that no currents are experienced with these high ripplings.

Phenomena of currents.

In the ocean, and also in narrow seas, currents frequently raise the sea, and agitate the surface greatly.—When the wind and current coincide in their direction, the sea generally is moderately smooth ; but it is agitated, and turbulent waves are produced, when the current runs in a contrary direction to the wind.—This is a general remark among nautical men, which often holds good ; although it does not always ensue : for turbulent waves are sometimes the effect of a strong current, when the direction of it and the wind agree.—It is singular that currents are very changeable in some parts of the ocean, far distant from land ; particularly near the equator.—I have several times, in low latitudes, experienced the current run upwards of sixty miles in twenty-four hours, to the eastward or westward ; then change suddenly, and set with equal velocity in the opposite direction, during the subsequent twenty-four hours.—The rise and fall of tides in most parts of the globe, appear to be much greater in high latitudes, than within the tropics : though currents seem to prevail more here, than in situations of the former

—very changeable.

mer kind.—In the Northern Atlantic they are seldom strong: but are frequently so near the equator, between the Coast of Guinea and the American Continent. About the southern limit of the Maldiva Isles, near the Equator, and to the eastward of the Philippine Islands, they are frequently strong and changeable.—In latitude 40°. South near the Cape of Good Hope, a strong current commenced suddenly, which produced a mountainous sea, when there was very little wind:—it continued to run strong for a day, then suddenly abated, and set in another direction with a gentle velocity; the high sea falling at the time.

Smooth and agitated portions of the sea with faint airs.

The agitated and smooth portions observed on the lakes, prevail much at sea in sultry weather, when nearly calm. At such times, the faint airs seldom agitate the surface of the sea in a regular manner, but the agitated and smooth portions, appear in veins and patches, intersecting each other in a variety of directions.—These appearances continue for days together, when faint airs and calms are experienced between the tropics: the faint airs are generally irregularly felt; sometimes gentle; at other times very weak, inclining to calm.—The surface of the sea to a considerable distance around a ship, always appears more smooth at these times, than at greater distances, towards the horizon; which often is the cause of belief in an approaching breeze, never realized.

The perspective makes the distant sea appear roughest.

Small medusæ and insects out at sea.

In low latitudes, when calms and faint airs have been experienced for two or three days; or for a longer period, I have frequently perceived the surface of the ocean have an oily appearance, with minute medusæ floating on it in great quantities.—They seemed to be interspersed over the smooth and agitated portions, and not confined to the smooth places.—Small insects, some with, and others without wings, have often been seen skipping on the surface of the sea in calm weather, many degrees distant from land.

Smooth places are seen during showers.

The smooth veins on the surface of the sea are also concomitant with rain; particularly at the commencement of showers, when there are gentle breezes of wind:—and sometimes appear to indicate rain.

Other facts respecting them.

Smooth veins on the surface of the sea prevail to the westward of the Laccadiva Islands, between these and the

 Island

Island Socotra, in the months of March and April; and are most perfectly depicted during brisk winds.

In these months the winds blow from the northward, in moderate and strong breezes, at a few degrees distance from the Coasts of Canara and Concan; and are mostly from N. N. W. to N. by E.—these winds do not blow uniformly, although the sky is generally clear, but come in gusts at short intervals; particularly in the night, the breezes being then stronger than in the day.

It is very common with these winds, to observe smooth veins on the surface of the sea, which extend in lines parallel to each other, and to the direction of the wind: they are often discernable in the night, when the moon exhibits no light, being so different in colour from the other parts these having a black appearance, occasioned by the fresh (or brisk) breezes agitating the surface and producing a great contrast between these agitated portions and the smooth veins.

Curious fact of a white dust deposited at sea.

Another curious phenomenon has frequently been observed to accompany these northerly winds, which is; in March or April, ships that are bound to Bombay or Surat, frequently have their rigging covered with white dust, although several degrees distant from the coast of Canara or Concan. The northerly and north north west winds, blowing from the coast of Persia, over an extensive surface of sea, (at least ten or twelve degrees) it is difficult to judge what can occasion the dust, if it is not generated in the atmosphere, which is in these months sometimes impregnated with a dry haze.

The gulph weed in the Atlantic Ocean is deposited in long parallel veins in the direction of the wind.

It may be observed, that similar to the smooth veins here mentioned, lying in the direction of the wind, is the direction of the veins or strata of Gulph Weed, in the middle of the Atlantic Ocean. The southern limit of this marine vegetating substance is about 22°. or 22½° north latitude, or near the tropic of Cancer; and the northern limit seems to be about the 42° of north latitude. It is always seen in long veins, or strata, parallel to each other, in the direction of the wind. When the wind changes, the veins of weed appear to be disturbed for a time; they are however not long before their direction is in conformity with the wind. These veins of weed are governed in their

direction

direction by the wind, whether the sea be smooth, or high; and in general do not appear to be more than from twelve to twenty hours, in changing their direction.

In No. 57 of your Journal, in a reply to M. M. your correspondent, the squall is thought to be occasioned by a descending wind, produced by the impulse of falling rain. This suggestion seems to agree with your observation, for I have several times, in calm weather, seen a cloud generate and diffuse a breeze on the surface of the sea, which spread in different directions from the place of descent. A remarkable instance of this occurred in Malacca Strait during a calm day, when a fleet was in company: a breeze commenced suddenly from a dense cloud, its centre of action seemed to be in the middle of the fleet, which was much scattered. This breeze spread in every direction from a centre, and produced a singular appearance in the fleet, for every ship hauled close to the wind as the breeze reached her, and when it became general, exhibited to view the different ships sailing completely round a circle, although all hauled close to the wind.

The author agrees with W. N. that the squall is a descending wind.

Remarkable instance in proof.

With this descending wind there was no rain fell on the ships at the extremities of the fleet, but a partial shower was observed to have fallen on the ships in the centre. Notwithstanding what has been just observed, squalls or brisk winds which commence suddenly after calms, are generally experienced to have their motion in a horizontal direction, when the impulse is perceived on the sails of a ship; but it appears probable, that the current of wind may descend until near the surface of the sea, when calm over the surface; and then be deflected in a horizontal direction on approaching it.

Your correspondent, M. M. thinks the velocity of the swell of the sea not greater than eight or ten miles an hour. It is much greater in general, but mutable according to circumstances.

The velocity of the swell is greater than supposed by M. M.

The velocity of the swell (or waves) in a strong breeze or trade wind, probably is about twenty miles an hour; for they pass a ship fast when she has a velocity of ten or eleven miles an hour in the same direction as the waves. At such times the velocity of the waves is easily measured with the common log, by noticing with a pro-

How to measure, &c.

 per

per quantity of line out, when the log is lifted on the top of a wave, marking this time, and measuring the interval from it to the time the ship's stern is lifted up by the same wave, by a watch with a second hand. The length of the line from the stern, compared with the interval of time, will give the excess of the velocity of the wave over that of the ship, and these added together will be the velocity of the wave. The velocity of the swell may also be obtained when calm, by sending a boat in the direction of the swell, to a moderate distance from the ship, having a line fast to each, to enable their distance to be measured. With a watch, measure the interval to the nearest second, when the boat was lifted up, by a swell, to the ship being lifted by it; compare the interval of time with the distance measured by the line to obtain the velocity of the swell. Several observations may be made in either case, and the mean taken as the result.

Less in shallow water.

The velocity of the waves seems generally less in shallow water, than in the ocean; the cause of this may be the resistance the particles of water meet with from mud or sand mixed in the water, or from friction against the ground.

Various swells at same time.

In the ocean it frequently happens that two swells run in directions opposing each other; at other times they cross each other obliquely: and sometimes three swells running in different directions, meet and run through each other; and continue to do so for a day or longer time, each retaining its own direction and apparent regular velocity.

The waves in the ty-fong.

It frequently happens during a ty-fong in the China sea, that the waves run in every direction; having the appearance of elevated mounts or pyramids, which infringe on each other with great violence. Ships are very liable to lose their rudders, when these pyramids strike against them; and the masts are endangered by the quick turbulent motion proceeding from such heterogeneous impulse.

Causes why the swell of the sea may precede the wind that caused it.

You remark that the swell caused by a storm, may be propagated with a greater mean velocity than the storm that causes it, and may therefore arrive on a coast before it, or come after the storm has ceased—this conclusion

seems just. The waves, (or swell) may be generated by a strong wind which has to contend with another blowing in opposition to it; this is frequently observed at sea; (seamen call it two winds fighting against each other) when this is the case, the velocity of a strong wind is greatly retarded, and its progress very slow whilst opposed by a breeze, although the latter be much inferior in strength:—and it frequently happens that a gentle breeze is prevalent over a strong wind, when the supply of the latter does not continue strong a sufficient length of time. The limit where two winds oppose each other, is sometimes observed to alter its position very little in two or three hours; a ship may continue to have a strong wind on one side of this limit for a considerable time, whilst a ship on the other side experiences a steady breeze from the opposite direction. It will therefore be easily comprehended, that when a strong wind has to overcome another wind, blowing in opposition to it, the velocity of the former must be slow until the latter is subdued, although the waves may speedily be agitated, and receive an impulse from it, by which they may greatly precede the wind that caused their formation. On the contrary, when a strong wind is diffused from the atmosphere, having no other wind to oppose it, the velocity of such must be greater than that of the waves formed by it; and consequently will precede the waves. Opposing winds.

In September 1802, there was a storm on the south coast of China, in which a Spanish frigate and the Nautilus of Calcutta were lost. We were about five degrees from the coast at the time; had pleasant weather and little wind:—A high swell reached us, by which we were (I may say) certain that a storm had happened on the coast; and on our arrival in a few days afterwards, found it had been so. Instance.

In December 1803, at anchor on the eastern sea-reef, at the entrance of Hooghley river, a gale of wind commenced, and blew from the northward, off the land: at the same time a heavy squall came rolling in from the sea, directly in opposition to the prevailing wind; this caused an apprehension that the gale would change suddenly, A storm from the N. with an heavy swell from the sea at the S.

denly, and blow from seaward, which did not happen. On the arrival of several ships soon after, the cause of the heavy swell rolling into the entrance of the river was ascertained; for these ships experienced a strong gale from southward, which brought them within about thirty leagues of the entrance of the river. This strong gale from the southward had forced a heavy swell greatly beyond its limit, although this swell must have met with great resistance from the strong northerly wind blowing against it.

Occasioned by a contrary gale.

Barometrical observations.

A long account from Capt. Flinders was recently read at the meetings of the Royal Society, descriptive of barometrical observations, made on the coast of New South Wales, &c. It appears that the mercury continued at greater heights with the wind from the sea, than with land winds, on the coast of New South Wales. I have sometimes observed the same effect in other places, particularly in June 1803 and July 1804, on approaching the coast of Cochinchina. In passing from Sincapour Strait to this coast in these months, with the regular southerly wind, the mercury performed the motions of two elevations and two depressions regularly, during the twenty-four hours; but fell ten hundred parts of an inch each time (suddenly) when we came near the land. At both times the wind from the sea abated, and was replaced with squalls from this alpine country. There was much vapour over the land both times; accompanied with vivid lightning.

The Mercury depressed by squally land breezes.

But not by regular land breezes.

During the fair weather season on the coast of Malabar, when regular land and sea breezes were daily experienced, the mercury in barometers was not depressed by these land breezes; but appeared equally high as when the breezes prevailed from the sea:—The two elevations and depressions of the mercury were continued every twenty-four hours on this coast; although not in equal quantity, as in a steady wind at a considerable distance from land.

III.

A Third Series of Experiments on an Artificial Substance, which possesses the principal characteristic Properties of Tannin; with some Remarks on Coal. By Charles Hatchett, *Esq. F.R.S.**

§ I.

Experiments, &c. on an artificial substance having the character of tanning matter.

In my former papers upon this subject, some account has been given of the effects produced by sulphuric acid upon turpentine, resin, and camphor; and I shall now state the results of other experiments made with the same acid upon a great number of the resins, balsams, gum resins, and gums, the greater part of which, afforded that modification of the artificial tanning substance, which for the sake of distinction, I have in the preceding papers denominated the third variety.

The process was simple digestion in sulphuric acid, after which, the residuum was well edulcorated, and was then digested into alcohol. This was separated by distillation, the dry substance which remained was infused in cold distilled water, and the portion dissolved, was examined by solution of isinglass, muriate of tin, acetite of lead, and sulphate of iron.

Much sulphureous acid, carbonic acid, several of the vegetable acids, particularly benzoic acid, (when the balsams were employed,) and apparently water, were produced during the operation; but in this paper I shall only notice two of the products, namely, the tanning substance and the coal.

The sulphuric acid almost immediately dissolved the resins, and formed transparent brown solutions, which progressively became black.

The same effect was produced on most of the other substances, but the solutions of the balsams and of guaiacum were at first of a deep crimson, slightly inclining to brown.

Caoutchouc and elastic bitumen were not dissolved,

* Philos. Trans. 1806. For the former papers see our Journal.

but

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but after having been digested for more than two months, were only superficially carbonized.

The gums and the saccharine substances required many evaporations and filtrations before the whole of their carbonaceous residua could be obtained.

These were the principal effects observed during the experiments, and I have stated them in this manner, that tedious and useless repetitions may be avoided.

§ II.

Turpentine, common resin, elemi, tacamahac, mastich, copaiba, copal, camphor, benzoin, balsam of Tolu, balsam of Peru, asa fœtida, and amber, yielded an abundance of the tanning substance.

Oil of turpentine also afforded much of it; asphaltum yielded a small portion; some slight traces of it were even obtained from gum arabic and tragacanth; but none was produced by guaiacum, dragon's blood, myrrh, gum ammoniac, olibanum, gamboge, caoutchouc, elastic bitumen, liquorice, and manna. I am persuaded, however, that many of these would have afforded the tanning substance had not the digestion been of too long a duration.

Olive oil was partly converted into the above mentioned substance, and also linseed oil, wax, and animal fat; but the three last appear to merit some attention.

Linseed Oil.

This oil with sulphuric acid very soon formed a thick blackish-brown liquid, which after being long digested in a sand-bath, was still partly soluble in cold water, and passed the filter. This solution precipitated gelatine; the residuum was a tough black substance, which became hard on exposure to air. A great part was soluble on alcohol, and formed a brown liquid, which became turbid by the addition of water. When this was evaporated, a brown substance remained, which was partially dissolved by cold water, and the solution thus formed, was rendered turbid by gelatine.

The undissolved portion left by the alcohol, was of a blackish-brown; it was soft and tenacious, and appeared to retain many of the properties of an inspissated fat oil.

Bleached Wax.

That which was employed in this experiment, was the white

white wax of the shops, which is sold in the form of small round cakes. It formed with sulphuric acid a thick black magma, and was not acted upon by cold distilled water when washed with it upon a filter. Upon being digested with alcohol in a sand-bath, a brownish solution was formed, which upon cooling became very turbid, and appeared as if filled with a white flocculent substance. The same operation was repeated with different portions of alcohol until this ceased to act. The whole of the solutions in alcohol were then mixed, a large quantity of distilled water was added, and the alcohol was separated by distillation.

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On the surface of the remaining liquor, when cold, a white crust was formed, which being separated, was found to possess the properties of spermaceti, and weighed 18 grains. The filtrated liquor was then evaporated to a small quantity, became of a pale brown colour, and was rendered turbid by solution of isinglass.

Animal Fat.

This experiment was made upon the kidney fat of veal, but I cannot take upon me to assert that the results would have been the same with every kind of fat. One hundred grains of it with one ounce of concentrated sulphuric acid, after some time, formed a blackish soft mass: a second ounce of sulphuric acid was then added, and the whole was digested and occasionally heated during nearly three months. Six ounces of distilled water were poured upon the black pulpy mass, and formed a thick uniform liquid, which, after digestion for six or seven days, was when cold filtrated. The liquor which passed was of a brown colour, and upon evaporation became black, leaving a considerable portion of a blackish substance upon the filter, which was added to that which had been collected by the first filtration. The whole was washed with cold water, which passed colourless. Boiling water was then poured upon the filter, by which a considerable portion was rapidly dissolved, and a brownish-black solution was formed, which copiously precipitated gelatine.

The residuum on the filter was then dried, and being collected, was digested in alcohol, which dissolved the greater part.

The solution in alcohol was filtrated, but (apparently

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by the effect of air) a considerable deposit was formed on the filter, which was again dissolved by alcohol. Water rendered the solution turbid, and a black light flaky substance, which weighed 41 grains, remained upon the filter. The filtrated liquor was then evaporated, and left a grayish-black substance, which weighed 30 grains. This last substance was highly inflammable, and when burned, emitted a very peculiar odour, resembling partly that of fat and partly that of asphaltum. It easily melted, and also immediately dissolved in cold alcohol, from which, like the resinous substances, it was precipitated by water.

The black light flaky residuum, which weighed 41 grains, was found to consist partly of the substance above mentioned and partly of coal, but the proportion of this last was not ascertained.

Coagulated albumen and prepared muscular fibre were also separately exposed to the action of sulphuric acid in the manner above described, but did not afford any substance by which gelatine could be precipitated, coal being the only product which remained.

Almost every one of the bodies which have been employed in these experiments, seem to be in some measure different in respect to the progressive effects produced upon them by sulphuric acid; and all other circumstances being similar, there appears to be a certain period of the process when the production of the tanning substance has arrived at its maximum, after which, a gradual diminution of it takes place, and at length total destruction. These effects are produced at different periods, according to the substance which may be the subject of the experiment, and therefore it is impossible at present to state the utmost quantity of the tanning substance which, under equal circumstances, may be obtained from each of the resins, balsams, &c.

The tanning substance appears to be always the same, whether obtained from turpentine, or common resin, or from the balsams, or from asa fœtida, or camphor, or indeed from any of the bodies which have been enumerated; its effects on the different reagents are similar; by the addition of a small portion of nitric acid, and subsequent evaporation, it is converted into that which I have called the first variety; or if digested with sulphuric acid, it is speedily

speedily destroyed, and becomes mere coal. In the latter case, therefore, the same agent which at first produced it becomes at length the cause of its destruction, and thus we find, that although a tanning substance may be obtained from resinous and other bodies by means of sulphuric and by nitric acid, yet in the former case the product is variable, and is formed at or about the mean period of the operation, whilst the latter is an ultimate and invariable effect, beyond which, no apparent change can be produced by any continuation of the process *.

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§ III.

I have already stated, that caoutchouc, and elastic bitumen, were only superficially acted upon when digested for a very long time in sulphuric acid; and it is remarkable, that these substances, which in their external characters so much resemble each other, should be similar in their habits when exposed to the effects of this acid: for, unlike the resins and most of the other bodies which were subjected to the preceding experiments, and which were almost immediately dissolved when the acid was poured upon them, these on the contrary remained undissolved, and only became partially carbonized on their surfaces. Even nitric acid does not so rapidly effect a change in the elastic bitumen as it does when applied to the other bituminous substances.

1.

One hundred grains of pure soft elastic bitumen were digested during three weeks in one ounce of nitric acid, diluted with an equal quantity of water; a tough and slightly elastic orange-coloured mass then remained. Another ounce of the acid, not diluted, was poured upon this mass, and the digestion was continued until the whole was evaporated. The residuum was tenacious, and of the colour above mentioned. Water partially dissolved it, and formed a deep yellow liquid, which copiously precipitated gelatine, and possessed the other properties of the tanning substance which is produced from the resins, &c. by nitric acid.

* In the former Papers upon this subject I have observed, that the tanning substance produced by sulphuric acid, is very inferior in energy to that, which is formed by nitric acid.

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An orange-coloured mass still remained, which was speedily dissolved by alcohol, and was precipitated from it by a large addition of water.

This substance in many of its properties resembled the resins, but in others, seemed to approach those which characterize the vegetable extractive matter. It appeared to be similar to that which has been cursorily mentioned in my first paper, and which was obtained from many of the pit-coals and bitumens when treated with nitric acid. I have since paid more attention to this substance during the following experiments:

Kilkenny coal was digested with nitric acid, and progressively, although with difficulty, was converted into that variety of the tanning substance which has so often been mentioned. Similar experiments were made on the same sort of coal from Wales, which was given to me by my friend Mr. Tennant, as well as upon a coal sent to me by Professor Woodhouse, which was from Pensylvania, and is there called Leigh high coal. All of these were converted into the tanning substance, but they did not yield any product similar to that obtained from the elastic bitumen.

The contrary however happened when the common pit-coal, or Cannel coal, or asphaltum, were employed. For when these were treated in the way which has been described, and when the digestion was not too long continued, then I obtained from 100 grains of each of the above substances (after the separation of the tanning matter) a residuum as follows:

From 100 grains of the common Newcastle coal 9 grains.
From 100 grains of Cannel coal. ....36 grains.
From 100 grains of pure asphaltum...........37 grains.

The substances thus obtained, were very similar in their external characters, being of a pale brown, approaching to Spanish snuff colour; their internal fracture was dark brown, with a considerable degree of resinous lustre. When exposed to heat they did not easily melt, but as soon as inflamed, they emitted a resinous odour mixed with that of fat oil, and produced a very light coal, much exceeding the bulk of the original substance.

Alcohol completely dissolved them, and if water in a large proportion was added to a saturated solution, a precipitate

precipitate was obtained, but after each precipitation, a portion always remained dissolved by the water, which acted upon the different reagents in a manner similar to the solutions of vegetable extractive matter. The flavour was also bitter, and in some degree aromatic, so that the residua, whether obtained from pit-coal, from Cannel coal, or from asphaltum, seemed to possess properties intermediate between those of resin, and those of the vegetable extractive substance. They appeared, however, to be removed only by a very few degrees from the tanning substance; for if digested in a small quantity of nitric acid, and subsequently evaporated, they were immediately converted into it; or if digested with sulphuric acid, they speedily became reduced to coal.

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§ IV.

In the 5th Section of my second Paper, some remarks were made on the decoctions obtained from vegetable substances which had been previously roasted; and although (excepting one instance) these decoctions did not afford any permanent precipitate with gelatine, yet I have there stated, that I did not think it right to conclude, that similar decoctions made under certain circumstances, might not occasionally possess those properties which characterize the tanning substances. Moreover I also observed in the same paper, that all of those decoctions, upon the addition of a small portion of nitric acid and subsequent evaporation, became converted into that variety of tanning matter which is produced by the action of nitric acid upon carbonaceous substances. I have since extended these experiments, and shall here give some account of them.

1.

Two hundred grains of the fresh peels of horse chesnuts were digested for about 12 hours in three ounces of distilled water. The liquor was of a pale brown, and formed a slight pale brown precipitate when solution of isinglass was added to it.

2.

Two hundred grains of the same peels were moderately roasted, and being afterwards digested with three ounces of water, formed a dark brown decoction, which was not rendered turbid by gelatine.

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3.

The above mentioned roasted peels, after the termination of the preceding experiment, were added to the remainder of the filtrated liquor. A quarter of an ounce of nitric acid was poured upon the whole, which was then digested and evaporated to dryness. The mass was afterwards infused in water, and a dark reddish-brown liquid was obtained, which copiously precipitated solution of isinglass.

4.

Two hundred grains of horse chesnuts, from which the peels employed in the former experiments had been taken, were bruised, and were digested with three ounces of water. The liquor was turbid, and of a pale red colour. It was filtrated, and some solution of isinglass was added, but without any effect.

5.

Two hundred grains of the same horse chesnuts were moderately roasted, and being treated as above described with water, yielded a dark brown decoction which was not rendered turbid by isinglass.

6.

The horse chesnuts, which had been employed in the preceding experiment with the remaining liquor, were digested with a quarter of an ounce of nitric acid until the whole was become dry. Water was then poured upon it, was digested, and a dark brown liquid was formed, which afforded a considerable precipitate by the addition of solution of isinglass.

From these experiments it appears, that the small portion of tannin which the horse chesnut peels originally contained, was destroyed by the process of roasting; that the brown decoction subsequently obtained from the roasted peels and from the horse chesnuts, did not act upon gelatine; but that these were speedily converted into the artificial tanning substance, by the addition of a small portion of nitric acid and subsequent evaporation.

The first preparations of the artificial tanning substance which have been mentioned in the former Papers, were made from coal of different descriptions digested with nitric acid, and as similar products have been obtained by the same acid from various decoctions of roasted vegetable

ble substances, there cannot be any doubt, that vegetable bodies when roasted, yield solutions by digestion in water, which essentially consist of carbon approaching to the state of coal, although not absolutely converted into it, for if so, all solubility in water would cease.

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But coal is apparently nothing more than carbon oxidized to a certain degree, and may be formed by the humid as well as by the dry way.

Examples have been already stated respecting operations in which sulphuric acid has produced this effect, but the same likewise appears to be produced with some modifications, whenever vegetable matter undergoes the putrefactive process; for when this takes place, as in dunghills, &c. a large proportion of the carbon of the original vegetable substances appears to be combined with oxygen sufficient to communicate to it many of the properties of coal, whilst the compound nevertheless is capable of being dissolved by water with the most perfect facility.

It must not however be understood that by this process all the other elementary principles are separated, so that only the carbon remains combined with oxygen, but merely, that the other principles are so far diminished, that these, namely, carbon and oxygen, predominate in a state approaching to coal, although soluble in water.

Such solutions, I have every reason to believe, are nearly similar to those afforded by vegetable substances which have been previously roasted, and although I have examined but a few of them, yet I shall relate some experiments which I have lately made on the peels of walnuts.

It is well known that when these are kept in small heaps for a short time, they become soft, and break down into a black mass, which affords a brownish-black liquor. On these I therefore made the following experiments:

1.

About one ounce of walnut peels, which were become soft and black, was digested in water.

A dark brown liquor was thus formed, and being filtrated, was examined by a solution of isinglass, but not any apparent effect was produced.

2.

On an equal quantity of walnut peels, in the same soft black

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black state, a small portion of nitric acid was poured, and after being digested for about five hours, the whole was evaporated to dryness. The residuum was of a brownish orange colour, and yielded a similar coloured solution to water when digested with it. This was filtrated, and upon the addition of solution of isinglass, became turbid, and deposited a tough precipitate, which was not dissolved by boiling water.

3.

Another portion of the walnut peels was moderately roasted, and was then digested in water; the brown solution was filtrated, and formed a slight precipitate with gelatine.

4.

On the residuum of the last experiment, a small quantity of nitric acid was poured, some water was then added, the whole was digested during about five hours, and until it became perfectly dry.

Water formed with this a brown liquor, which yielded a very abundant precipitate by the addition of dissolved isinglass.

Upon these experiments we may remark, that the solution in the first instance contained carbon in a state approaching to coal, for when treated with nitric acid in the second experiment, a portion (although small) was produced of the same tanning substance which is formed from the different kinds of coal by nitric acid.

The third experiment appears to shew, that a small quantity of a substance approaching to tannin was produced by the simple process of roasting; and the fourth experiment corroborates those already described, in which, the artificial tanning matter was copiously produced, whenever roasted vegetable substances were treated with nitric acid.

In respect to vegetable substances, especially those which contain tannin, I shall here relate a few other experiments.

It has been remarked in my second Paper, (p. 288,) that the tannin of galls was immediately destroyed by nitric acid. Since that time, I have made the following additional experiments:

One

1.

One hundred grains of galls reduced to powder were infused with four ounces of water, and part of the infusion upon the addition of solution of isinglass afforded (as usual) a copious precipitate of a brownish-white colour.

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A quarter of an ounce of nitric acid was added to one ounce of the above infusion, which then, was not in any manner affected by the dissolved isinglass.

2.

One hundred grains of the same galls were slightly roasted, and being digested with four ounces of water, formed a brown liquor, which was filtrated.

Solution of isinglass was then added to a part of the above liquor, and produced a precipitate not very unlike the former, but much less in quantity.

After this, a quarter of an ounce of nitric acid was added to one ounce of the same liquor, and some dissolved isinglass was subsequently poured into it, by which it was rendered turbid, and a small portion of a dark brown precipitate was produced, resembling that which is commonly afforded by the artificial tanning substance.

3.

The remainder of the above mentioned liquor, with the residuum of the roasted galls, were digested with a quarter of an ounce of nitric acid until the whole had become dry. Water was then poured upon it, and formed a dark brown solution, which yielded a copious brown precipitate by the addition of dissolved isinglass.

From these experiments on galls it appears, that the natural tannin contained in them is destroyed by nitric acid; that the tannin is also diminished, (and I may add,) is ultimately destroyed by the process of roasting; that when galls have not been so far roasted as to destroy the whole of the tannin, then the remainder of this seems to be destroyed by the addition of nitric acid, whilst at the same time a small portion of the artificial tanning substance is produced; and that this last is always plentifully afforded by roasted galls when digested with nitric acid, similar to other vegetable bodies when thus treated.

These remarks are also partly confirmed by the following experiments upon oak bark.

Two

1.

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Two hundred grains of oak bark, reduced into very small fragments, were infused in about four ounces of water, after which the infusion was examined by dissolved isinglass, and yielded a considerable precipitate.

2.

Two hundred grains of the same sort of bark were slightly roasted, and afterwards digested in water; a much darker coloured liquor was obtained than in the former case; but although it afforded precipitates by the addition of the muriate of tin, acetite of lead, and sulphate of iron, yet not the smallest effect was produced by solution of isinglass.

3.

The residuum, with the remaining part of the above mentioned liquor, was then digested with a small portion of nitric acid; this was completely evaporated, and a brown solution was formed by water, which abundantly precipitated gelatine.

4.

One ounce of oak bark, reduced into very small fragments, was repeatedly digested in different portions of water until the whole of its tannin was extracted. The residuum or exhausted bark (as it is called by the tanners) was dried, and was afterwards moderately roasted. It was then moistened with diluted nitric acid, which was evaporated in a heat not much exceeding 300° until the bark was become perfectly dry. This was digested in water, and speedily formed a yellowish-brown liquor, which abundantly precipitated gelatine.

5.

The bark, which after being exhausted of its natural tannin, had thus afforded the artificial tanning substance, was repeatedly treated with water until the whole of this last was extracted. The bark was then again slightly roasted, was again moistened with nitric acid, and was gently heated and dried as before. Water being poured on it and digested, formed a brown solution, which copiously precipitated gelatine.

1 The

6

The whole of the artificial tanning substance was extracted by different portions of water, and the remainder of the bark thus exhausted, was again treated in the manner above described, and again afforded a considerable quantity of the tanning substance, so that these processes evidently might have been continued until the whole of the bark had been converted into it.

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This might also have been accomplished, if in the first instance, the exhausted bark had been converted into charcoal, and digested in nitric acid, as described in my first Paper; but then, the effects would have been more slowly produced, and much more nitric acid would have been consumed. I am now therefore fully convinced, not only by the results of the experiments related in this Paper; but also by many others which it would have been superfluous to have stated, that the most speedy and most economical of all the processes which I have described, is that of treating roasted vegetable substances in the way which has been mentioned, and considering that all refuse vegetable matter may be thus converted into a tanning substance by means the most simple, and without any expensive apparatus, I cannot help entertaining much hope, that eventually this discovery will be productive of some real public advantage.

§ V.

In my first Paper I have remarked, that I suspected the tannin of the peat moors to have been produced during the imperfect carbonization of the original vegetable substances. Whether this has been the case, or whether the tannin has at times been afforded by heath and other vegetables growing upon or near the peat, still appears to me to be uncertain; but whatever may be the origin, I never have yet been able to detect any tanning substance in peat, although I have examined a considerable number of varieties, some from Berkshire, and many from Lancashire, which were obligingly sent to me for this purpose by my friend John Walker, Esq. F. R. S. Mr. Jameson has also made the same observation,* so that there

* An Outline of the Mineralogy of the Shetland Islands, &c. 8vo. edition, p. 174.

cannot

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cannot be any doubt (whatever the origin of the tanning matter may have been) that it has speedily been extracted and drained from the substances which first contained it.

This effect is a natural consequence of the great facility with which tannin is dissolved by water, and extends even to the most solid vegetable bodies; I shall here give an example.

In the Philosophical Transactions for 1799, Dr. Correa de Serra has given an account of a submarine forest at Sutton, on the coast of Lincolnshire, where submerged vegetables are found in great abundance, including trees of different descriptions, especially birch, fir, and oak. At the time when I was engaged in those experiments on the Bovey coal, and other substances of a similar nature, which have been printed in the Philosophical Transactions for 1804, Sir Joseph Banks had the goodness to send me a piece of the oak, which was perfect in all of its vegetable characters, and did not appear to have suffered any change excepting, that it was harder, and of a darker colour than recent oak wood. From some experiments which I then made, I found, that after incineration it afforded potash, similar to the recent wood, and contrary to substances like the Bovey coal, which retain the vegetable external characters, although imperfectly converted into coal*.

In the course of my experiments on tannin, I reduced about an ounce of this submerged oak into shavings, and digested them in water. A brown decoction was formed, which with muriate of tin afforded a pale brown precipitate; with acetite of lead, a precipitate of a deeper brown; with sulphate of iron, a copious brownish-black precipitate; but with solution of isinglass not any effect was produced.

The tannin of this oak wood, had therefore either been separated by solution, or had been decomposed; so that the only substance which remained capable of being dissolved by water, was the extractive matter. This last, in the present case was most probably the original extractive matter of the oak, but in some other instances, (such, for example, as that which was found in the alder leaves

* Phil. Trans. for 1804, p. 399.

contained

contained in the Iceland schistus.*) I am much inclined to believe, that an extractive substance of secondary formation, if I may be permitted to employ such a term, is produced during the process of carbonization. If a substance, therefore, so compact and solid as oak timber can by long submersion, be deprived of its tannin, it naturally follows that the same effect must be more speedily produced by the action of water on the smaller vegetable bodies, which present an extensive surface, and also on porous and bibulous substances such as peat.

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But although peat, as I have already observed, does not contain any tannin, yet the imperfect carbonization which it has undergone, renders it like the roasted ligneous bodies, peculiarly susceptible of being converted into the artificial tanning substance when exposed to the action of nitric acid. It would be useless to enter into a detail of the different experiments which I have made upon it, as they were similar to those already related, and I shall therefore only here state, that when seven ounces of well dried peat had been twice moistened, and digested with diluted nitric acid, (to the amount of rather more than two ounces,) and subsequently dried, I obtained by water a solution of the artificial tanning substance, which when evaporated to dryness weighed two ounces. I am convinced, that much more might have been obtained from the residuum of the peat, had I thought proper to have repeated the operation; and I am also certain, that less nitric acid would have been sufficient, had the process been conducted in close vessels, and with other economical precautions, which at that time, were for the sake of expedition and convenience omitted.

§ VI.

It has been generally stated, even by modern chemists, that the acids act but little, if at all, upon resinous substances.

The contrary has however been proved, not only in the three Papers upon the present subject, but also in some others which I have formerly had the honour to lay before this learned society.

In my experiments on lac, printed in the Phil. Trans.

* Phil. Trans. for 1806, p. 391.

for

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for 1804, p. 208, I have particularly endeavoured to shew, how powerfully the acetic acid acts upon resin, gluten, and some other substances; so that it may justly be regarded, as a valuable agent in the chemical analysis of vegetable bodies. In this point of view, it is as a solvent to be the more highly appreciated, because it appears to dissolve the resins, &c. without affecting their respective qualities, and thus by proper precipitants, these substances may be separated from it pure and unaltered.

I am induced therefore to consider acetic acid to be the true acid solvent of the resinous substances, as it dissolves them speedily, without producing any apparent subsequent change in their natural properties.

Sulphuric acid also, almost immediately dissolves the resins, balsams, &c. and forms transparent brown or sometimes crimson solutions, the latter colour being most commonly characteristic of the balsams.

These solutions, however, are different from those made in the acetic acid, by not being permanent, for from the moment when the solution is completed, progressive alterations appear to be produced in the body which is dissolved; thus turpentine is almost immediately converted into resin, then into the third variety of the tanning substance, and lastly into coal.

Without being under the necessity of adducing other examples, we may therefore state sulphuric acid to be a solvent of the resinous substances, but which continues afterwards to act on their principles, so as to decompose them, coal being the ultimate product.

Nitric acid, as I have shewn in the course of these Papers, and likewise on some former occasions, dissolves the resins, but the progress of its effects seems to be conversely that of sulphuric acid; in the latter case, solution precedes decomposition; but when nitric acid is employed, decomposition to a certain degree precedes solution; for it at first converts the resins into a pale orange coloured brittle porous substance, then into a product, which apparently possesses the intermediate characters of vegetable extractive matter and of resin, and lastly, this is converted into the first variety of the tanning substance, beyond which I have not been able to effect any change.

As

As coal therefore appears to be the ultimate effect produced by sulphuric acid upon the resinous bodies, so does the first variety of the tanning substance seem to be the terminating product afforded by the same when acted upon by nitric acid. This effect of nitric acid has been already amply discussed, neither does it appear necessary that I should here repeat the remarks which have been made on some of the simultaneous products, such as the vegetable acids; but amongst the effects produced by sulphuric acid, the coal which is formed seems to merit some attention.

[The remainder in our next.]

IV.

On the Force of Percussion. By WILLIAM HYDE WOLLASTON, *M.D. Sec. R.S. Being the Bakerian Lecture which was read before the Royal Society in the month of November last*.*

WHEN different bodies move with the same velocity, it is universally agreed that the forces, which they can exert against any obstacle opposed to them, are in proportion to the quantities of matter contained in the bodies respectively. But, when equal bodies move with unequal velocities, the estimation of their forces has been a subject of dispute between different classes of philosophers. LEIBNITZ and his followers have maintained that the forces of bodies are as the masses multiplied into the *squares* of their velocities, (a multiple to which I shall for conciseness give the name of *impetus*); while those, who are considered as NEWTONIANS, conceive that the forces are in the *simple ratio* of the velocities, and consequently as the *momentum* or *quantitas motus*, a name given by NEWTON to the multiple of the velocity of a body simply taken into its quantity of matter.

Concise statement of the dispute concerning the forces of bodies in motion.

It cannot be expected that at this time any new experiment should be thought of, by which the controversy can be decided, since the most simple experiments that

* From the Phil. Trans. for 1806.

have

have already been appealed to by either party have received different interpretations from their opponents, although the facts were admitted.

The Newtonian explanation of the third law of motion is not contrary to the followers of Leibnitz.

My object in the present lecture is to consider which of these opinions respecting the force exerted by moving bodies is most conformable to the usual meaning of that word, and to shew that the explanation given by NEWTON of the third law of motion is in no respect favourable to those who in their view of this question have been called NEWTONIANS.

If bodies were made to act upon each other under the circumstances which I am about to describe, the leading phænomena would occur, which afford the grounds of reasoning on either side.

Statement of the leading phenomenon.

Let a ball of clay or of any other soft and wholly inelastic substance be suspended at rest, but free to move in any direction with the slightest impulse; and let there be two pegs similar and equal in every respect inserted slightly into its opposite sides. Let there be also two other bodies, A and B, of any magnitude, which are to each other in the proportion of 2 to 1; suspended in such a position, that when perfectly at rest they shall be in contact with the extremities of the opposite pegs without pressing against them. Now if these bodies were made to swing with motions so adapted that in falling from heights in the proportion of 1 to 4 they might strike at the same instant against the pegs opposite to them, the ball of clay would not be moved from its place to either side; nevertheless the peg impelled by the smaller body B, which has the double velocity, would be found to have penetrated twice as far as the peg impelled by A.

It is unnecessary to make the experiment precisely as here stated, since the results are admitted as facts by both parties; but upon these facts they reason differently.

Inferences concerning the forces as deduced by each party.

One side observing that the ball of clay remains unmoved, considers the proof indisputable that the action of the body A is equal to that of B, and that their forces are properly measured by their momenta, which are equal, because their velocities are in the simple inverse ratio of the bodies. Their opponents think it equally proved by the unequal depths to which the pegs have penetrated, that the

the causes of these effects are unequal, as they find to be the case in their estimation of the forces by the squares of the velocities.

One party is satisfied that equal *momenta* can resist equal pressures during the same *time;* the other party attend to the *spaces* through which the same moving force is exerted, and finding them in the proportion of 2 to 1, are convinced that the *vis viva* of a body in motion is justly estimated by its magnitude and the square of its velocity jointly.

In the one consideration the time of action is attended to; in the other the result or work performed. — This is practically more useful.

The former conception of a quantity dependent on the continuance of a given *vis motrix* for a certain *time* may have its use, when correctly applied, in certain philosophical considerations; but the latter idea of a quantity resulting from the same force exerted through a determinate *space* is of greater practical utility, as it occurs daily in the usual occupations of men; since any quantity of work performed is always appreciated by the extent of effect resulting from their exertions; for it is well known, that the raising any great weight 40 feet would require 4 times as much labour as would be required to raise an equal weight to the height of 10 feet, and that in its slow descent the former would produce 4 times the effect of the latter in continuing the motion of any kind of machine. Moreover, if the weights so raised were suffered to fall freely through the heights that have been ascended by means of 4 and 1 minute's labour, the velocities acquired would be to the ratio of 2 to 1, and the squares of the velocities in proportion to the quantities of labour from which they originated, or as 4 to 1; and if the forces acquired by their descent were employed in driving piles, their more sudden effects produced would be found to be in that same ratio.

It has been called mechanic force,

This species of force has been, first by Bernouilli and afterwards by Smeaton, very aptly denominated mechanic force; and when by force of percussion is meant the quantity of mechanic force possessed by a body in motion, to be estimated by its quantity of mechanic effect, I apprehend it cannot be controverted that it is in proportion to the magnitude of the body and to the square of its velocity jointly.

 But

and is no where treated of by Newton.

But of this quantity of force NEWTON no where treats, and has accordingly given no definition of it. If, after defining what he meant by the *quantitas acceleratrix*, and *quantitas motrix*, he had had occasion to convey an equally distinct idea of the *quantitas mechanica* resulting from the continued action of any force, he might, not improbably, have proceeded conformably to the definition given by SMEATON, and have added

——quantitas mechanica est mensura proportionalis spatio per quod data vis motrix exercetur;

or, if speaking with reference to the accumulated energy communicated to a body in motion,

——proportionalis quadrato velocitatis quam in dato corpore generat.

But, if we attend to the words of his preface to the first edition of his *Principia*, he evidently had no need of such a definition;

"Nos autem non artibus sed philosophiæ consulentes, "deque potentiis non manualibus sed naturalibus scri-"bentes," &c.

And again, nearly to the same effect in the *Scholium*, which follows the laws of motion, "Cæterum mechani-"cam tractare non est hujus instituti."

Newton speaks of pressures, & not of percussion.

In the third law of motion he has on the contrary been supposed to speak of this force from an ambiguity in the signification of the words *actio* and *reactio*. By these, however, NEWTON certainly meant a mere *vis motrix* or pressure, as he himself explains them. "Quicquid pre-"mit vel trahit alterum, tantundem ab eo premitur vel "trahitur. Si quis lapidem digito premit, premitur et "hujus digitus a lapide," &c. The same meaning is equally evident from his demonstration of the third corollary to the laws, in which he asserts that the *quantitas motûs* of two or more bodies estimated in any given direction is not altered by their action upon each other. The demonstration begins thus:

"Etenim actio eique contraria reactio æquales sunt "per legem tertiam, ideoque per legem secundam æqua-"les in motibus efficient mutationes versus contrarias "partes." Now, if he had considered the third law as implying equality of more than mere moving forces, there could

could have been no occasion to refer to the second law, with a view thence to deduce the equality of momenta produced.

A more complex consideration of the third law.

Some authors however have interpreted the third law differently, and accordingly have expressed a difficulty in comprehending the simple illustration given by NEWTON. When they say that action is equal to reaction, they mean not only that the instantaneous intensity of the moving forces, or pressures opposed to each other, are necessarily equal, but conceive also a species of accumulated force residing in a moving body, which is capable of resisting pressure during a *time* that is proportional to its momentum or quantitas motus.

If it be of any real utility to give the name of force to this complex idea of *vis motrix* extended through time, as well as that of *momentum* to its effects when unresisted, it would be requisite to distinguish this force always by some such appellation as *momental* force; for it is to be apprehended that for want of this distinction many writers themselves, and it is certain that many readers of disquisitions on this subject have confounded and compared together *vis motrix*, *momentum*, and *vis mechanica*: quantities, that are all of them totally dissimilar, and bear no more comparison to each other, than lines to surfaces, or surfaces to solids.

The momentum of bodies is seldom to be considered in practical mechanics.

In practical mechanics, however, it is at least very rarely that the *momentum* of bodies is in any degree an object of consideration: the strength of machinery being in every case to be adapted to the *quantitas motrix*, and the extent and value of the effect to be produced depending upon the *quantitas mechanica* of the force applied, or in other words to the space through which a given vis motrix is exerted.

Smeaton has well treated of mechanic force.

The comparative velocities given by different quantities of mechanic force to bodies of equal or unequal magnitude, have been so distinctly treated of by SMEATON, in a series of most direct experiments*, that it would be a needless waste of time to reconsider them in this place. So also, on the contrary, the quantities of extended me-

* Phil. Trans. Vol. LXVI. 450.

chanic effect producible by bodies moving with different quantities of impetus have been as clearly traced by the same accurate experimentalist*.

Farther considerations respecting forces.

But there is one view, in which the comparative forces of impact of different bodies was not examined by SMEATON, and it may be worth while to shew that when the whole energy of a body A is employed without loss in giving velocity to a second body B, the *impetus* which B receives is in all cases equal to that of A, and the force transferred to B, or by it to any third body C, (if also communicated without loss, and duly estimated as a mechanic force,) is always equal to that from which it originated.

As the simplest case of entire transfer, the body A may be supposed to act upon B in a direct line through the medium of a light spring, so contrived that the spring is prevented by a ratchet from returning in the direction towards A, but expands again entirely in the direction towards B, and by that means exerts the whole force which had been wound up by the action of A, in giving motion to B alone. In this case, since the moving force of the spring is the same upon each of the bodies, the accelerating force acting upon B at each point is to the retarding force opposed to A at the corresponding points in the reciprocal ratio of the bodies, and the squares of the velocities produced and destroyed by its action through a given space will consequently be in that same ratio. The momentum, which is in the simple reciprocal ratio of the bodies, might consequently be increased at pleasure by the means proposed, in the subduplicate ratio of the bodies employed; and if momentum were an efficient force capable of reproducing itself, and of overcoming friction in proportion to its estimated magnitude, the additional force acquired by such a means of increase, might be employed for counteracting the usual resistances, and perpetual motion would be easily effected. But since the *impetus* remains unaltered, it is evident that the utmost which the body B could effect in return would be the reproduction of A's velocity, and restitution of its

* Phil. Trans. Vol. LXXII. 337.

entire

entire mechanic force neither increased nor diminished, excepting by the necessary imperfection of machinery. The possibility of perpetual motion is consequently inconsistent with those principles which measure the quantity of force by the quantity of its extended effect, or by the square of the velocity which it can produce.

Considerations respecting mechanic force.

In estimating the utmost effect which one body can produce upon another at rest, the same result is obtained by employing *impetus* as ascensional force, according to HUYGENS; for if the body A were allowed to ascend to the height due to its velocity, and if by any simple mechanical contrivance of a lever or otherwise the body B were to be raised by the descent of A, it is well known that the heights of ascent would be reciprocally as the bodies; and consequently that the *square* of the velocity to be acquired by free descent of B would be in that ratio, and the quantity of mechanic force would be preserved as before unaltered.

It may be of use also to consider another application of the same energy, and to shew more generally that the same quantity of total effect would be the consequence not only of direct action of bodies upon each other, but also of their indirect action through the medium of any mechanical advantage or disadvantage; although the time of action might by that means be increased or decreased in any desired proportion. For instance, if the body supposed to be in motion were to act by means of a lever upon a spring placed at a certain distance from the centre of motion, the retarding force opposed to it would be inversely as the distance of the body from the centre; and since the space through which the body would move to lose its whole velocity would be reciprocally as the retarding force, the angular motion of the lever and space through which the spring must bend, would be the same, at whatever point of the lever the body acted. And conversely, the reaction of the spring upon any other body B, would in all positions communicate to it the same velocity.

It may be remarked, however, that the times in which these total effects are produced may be varied at pleasure in proportion to the distances at which the bodies are

placed

Considerations respecting mechanic force.

placed from the centre of motion; and it should not pass unobserved that, although the intensity of any *vis motrix* is increased by being placed at what is called a mechanical advantage, yet on the contrary, any quantity of mechanic force is not liable to either increase or diminution by any such variation in the mode of its application.

Since we can by means of any mechanic force consisting of a *vis motrix* exerted through a given *space*, give motion to a body for the purpose of employing its *impetus* for the production of any sudden effect, or can, on the contrary, occasion a moving body to ascend, and thus resolve its *impetus* into a moving force ready to exert itself through a determinate space of descent, and capable of producing precisely the same quantity of mechanic effect as before, the force depending on *impetus* may justly be said to be of the same kind as any other mechanic force, and they may be strictly compared as to quantity.

In this manner we may even compare the force of a body in motion to the same kind of force contained in a given quantity of gunpowder, and may say that we have the same quantity of mechanic force at command whether we have 1lb. of powder, which by its expansion could give to 1 ton weight a velocity sufficient to raise it through 40 feet, or the weight actually raised to that height and ready to be let down gradually, or the same weight possessing its original velocity to be employed in any sudden exertion.

By making use of the same measure as in the former cases, a distinct expression is likewise obtained for the quantity of mechanic force given to a steam-engine by any quantity of coals; and we are enabled to make a comparison of its effect with the quantity of work that one or more horses may have performed in a day, each being expressed by the space through which a given moving force is exerted. In the case of animal exertion however, considerable uncertainty always prevails in consequence of the unequal powers of animals of the same species, and varying vigour of the same animal. The information which I have received in reply to inquiries respecting the weights raised in one hour by horses in different

different situations, has varied as far as from 6 to 15 tons to the height of 100 feet. But although the rate at which mechanic force is generated may vary, any quantity of work executed is the same, in whatever time it may have been performed.

Considerations respecting mechanic force.

In short, whether we are considering the sources of extended exertion or of accumulated energy, whether we compare the accumulated forces themselves by their gradual or by their sudden effects, the idea of mechanic force in practice is always the same, and is proportional to the *space* through which any moving force is exerted or overcome, or to the *square* of the velocity of a body in which such force is accumulated.

V.

Letter from a Correspondent, affirming, contrary to some Observations in our last Number, that objects can be distinguished by the Human Eye under Water, with additional experiments by the Editor.

London Institution, 22d Aug. 1806.

To Mr. Nicholson.

Sir,

I have just laid down your Journal for the present month, and feel myself not a little surprised at your dissertation on swimming, and your observations on what Dr. Franklin has written on that subject.

Your objection to the Doctor's mode of giving confidence to those who wish to acquire the art, appears to me not founded on fact, at least not general fact; you seem to think the Doctor's plan like the senatûs consultum of the mice, a very good one, but quite impracticable: now I find two very learned men differing upon a particular ascertainable point, ascertainable to any one who has eyes formed without some very uncommon defect, and who has, at the same time, courage enough to plunge his head under *clear* water. (For the sharpest sighted man cannot see in water, where the light is shut out by mud floating in it, or by the sides of a vessel that is too small to admit its rays, any more than in a room where light is shut out by the window shutters being closed).

Remark on Dr Franklin's supposition that objects can be distinguished by divers.

I have

I have reason to conclude that both yourself and Dr. Franklin are swimmers, although by your own confession you cannot be a very adept diver; you could not at that time however, when you vainly endeavoured to regain your silver buckle, shining as the substance was, in four feet water.

Conjecture that W. N. is misled by fancy in concluding that they cannot.

I believe that very studious and scientific men do oftentimes in their studies, hit upon some fanciful theoretical point, upon which they build, without that solid base which their own knowledge would easily discover, were they to consult it.

Complimentary apology.

I ought, I am well aware, to beg pardon when I presumed to differ from a man so learned and of such eminent abilities as yourself; and were it a point of theory, which depended on the mind's eye, I should, if I did not see the subject in the same light as yourself, impute it to a mental opthalmia on my part, and not think of offering an opinion in opposition to yours. But in this case, I cannot help thinking there must be some essential difference in the formation of the crystaline humour of your eyes, or in the body of the waters wherein you have tried your experiments; for I have frequently dived, not in the Indies, but no farther off than Eton, in the Thames, in water from six to ten feet deep, for things thrown down to the bottom for the very purpose of diving to bring them out again, and have done it with success; and my schoolfellows doing the same, I could not suppose the property of seeing under water, was peculiar to myself; but as I was never very fond of diving much, I have not of late practised it, yet doubt not I could do the same thing were I now to try.

The author states that he can see very well under water.

I trust you will excuse me for the liberty I have taken in thus troubling you; but I did not think it right that an error should go forth to the world, under the sanction of a name that carries with it such weight.

I am, Sir,
With the greatest respect,
Your very obedient servant,
A DIVER.

P. S. If you should be satisfied of the above mistake, I hope you will mention it in your next number.

Reply by W. N.

THE proper answer to the preceding letter will consist in relating a few experiments which I have just made, along with two of my friends.

We took neither Oriental nor Batavian waters, but a portion from that venerable stream in which my correspondent and his schoolfellows so successfully exercised their sight. With this we filled a glass cylindrical vessel, 2 feet high and 1 foot wide, standing upon a white (paper) ground. Two pieces of black lead, sawed square, were put into the water, one of which is one inch and a half wide, and the other only half an inch. Both these pieces were very distinctly seen by the eye above the water, but they were not visible to any of us when we looked at them with the face plunged beneath the surface.

Experiment. A glass vessel, two feet deep, was filled with Thames water.

The larger piece exhibited a darkish hazy appearance, which was very faint and not at all likely to have been noticed, if the attention had not been steadily directed to its known place. The smaller piece did not perceptibly affect the white ground.

A square of an inch and a half scarcely discernable; a smaller square invisible

A square piece of cork was fixed to a bended rod, so that it could be plunged to different depths in the water. At the bottom of the vessel, it was quite invisible to the immersed eye. I could just see that it was square when at the distance of six inches. Others were not satisfied as to its figure, but at a less distance.

Cork square, of an inch, invisible, unless very near.

A buckle and an egg were also tried, the former was invisible, and the egg (upon a black ground) was very hazy, confused and indistinct, so that we did not think it could have been found by sight, by a diver.

A buckle and an egg.

Various convex lenses were applied to the eye, under water, in order to bring the rays to their proper focus on the retina. The lens which answered our purpose, is a double convex crystal glass of half an inch focus in the air (but two inches from under water) when this lens was held close to one of the immersed eyes, the other being shut, the objects at the bottom of the water were distinctly seen. I clearly observed the saw marks on the black lead

A convex lens of half an inch focus enabled the eye to see distinctly.

lead, several small matters adhering to the egg and an air bubble of one twentieth of an inch diameter, which adhered to the buckle.

The eye saw best at first immersion.

We all remarked that the appearance under water, to the naked eye, became less distinct after the eye had been a second or two under the water than at first. I do not apprehend why this should be the case.

Conclusion that the human eye cannot distinguish objects under water.

From the preceding facts as well as from optical considerations, it appears to be established that men and probably all animals which live in the air, are incapable of varying the adjustment of the eye, so as to distinguish objects, with even a very small degree of precision, at a very remarkable distance from that organ immersed in water. Instead however of reasoning, as my correspondent has done in his fourth paragraph, I am disposed to question whether a farther enquiry into the facts, with different individuals, might not shew that some persons may be capable of altering the form of their eyes enough to see imperfectly in the situation we have been contemplating; but I must confess that I do not incline to that opinion.

Another instance of a person swimming at first time.

Since I wrote the paper in my last, I have heard of another well authenticated instance of a man who had never attempted to swim, but who, on the occasion of having fallen from a barge into the Thames, supported himself for a considerable time by striking his hands downwards alternately, until a boat, for which he loudly called, came to his assistance.

VI.

History of the Developement of the Intellect and Moral Conduct of an Infant during the first Twelve Days of its Existence. In a Letter from R. B.

To Mr. NICHOLSON.

SIR,

Introduction to this memoir.

SIX years ago I communicated to a respectable periodical publication, a register of the moral conduct of an infant for the first twelve days of its existence. That work was soon afterwards discontinued, which prevented my communica-

 ting

ting any farther continuation of an history which seems calculated to give instruction to many of those whose researches have been directed towards the habits and progress of the human mind. From the very moderate success of the work alluded to (which was not calculated for the million) I consider my memoir as yet unpublished. If, Mr. Nicholson, it should so far meet your approval, and coincide with the plan of your excellent Journal, as to obtain insertion, I shall take the liberty to communicate the remaining part of my register, which will bring the history to a period when infants are in some measure admitted to and supposed capable of mutual intercourse with persons of more advanced age.

Inquiries made by a parent respecting infants.

I am the father of many children, and consequently it is now a considerable number of years since I experienced the first emotions of a parent. At that period, every movement, every action of the little being of which I was destined to be the protector and guide, were subjects of curiosity and interest. My speculations on its figure, its passions, and the gradual developement of its understanding, were numerous, rapid, and confused. When I went into society, I made inquiries of the age of children in every stage of advancement, and classed their attainments in regular progression for my own use, in estimating what I was to expect from the new object of my regards. One month passed after the other, and my acquisitions of knowledge, both physical and moral, respecting the early stage of our existence, became greater, while my entertainment and surprise were such as, perhaps, can be rightly estimated by none but those who have themselves been parents. After the lapse of two years, I was again a father, but found, with some mortification, that I had nearly forgotten all my stock of knowledge, and that the same series of remarks was again to be made. I then made a few notes; but with so little precision, that they were scarcely of any use, when on a subsequent discussion with an author of high reputation concerning the influence of education, I was desirous of examining the value of the facts which have led me to conclude that our mental powers are originally as different as our physical; and that, at the moment of birth, our structure

 and

and moral habits are so far formed, that a physiognomist would find no difficulty in writing the character of an infant an hour old.

This incident led me to make a fuller register of the manners and progress of my ninth infant; which, however, upon review, I find to be much less precise than I now wish. Such as it is, I shall, however, make it the basis of my present communication.

First efforts of an infant as actually observed

The circumstances of parturition had so far exhausted the infant (a female) that instead of immediate respiration and crying, as commonly happens, the time of thirty seconds elapsed before she breathed; during which she occasionally opened her mouth to the utmost. The respiration commenced with a convulsion of the thorax, or single hiccup; soon after which the funis was divided, and she was delivered to me*. During the following seven or eight minutes, her respiration was several times suspended for an instant; at the end of which, the system was enough recovered to obey the repeated voluntary exertions she made, and she cried freely. Before this time the head had assumed its regular figure, and had entirely lost the elongation produced by the act of parturition.

The following are the observations of physiognomy † made on the day of birth, and abundantly confirmed, as far as the present age of the subject (three years) can show.

Estimate of her character, &c. from her figure and conduct.

The general figure of the head is capacious, regularly oblong, nearly circular behind, and narrowed above the forehead.

* It is not the custom of this country for the father to be present at events of this nature; but I am well convinced that his presence, if he possess firmness, good sense, and affection, is calculated to produce the happiest effects.

† I am very little disposed to apologise for observations of physiognomy. Those who deride them the most, are perpetually making them. That an individual has an intelligent, a stupid, a malignant, a ferocious, a timid, a courageous, &c. look;—that his manner is spirited, dignified, generous, or mean, contemptible, base, sneaking;—these are terms as familiar as any in our language; they are applicable to paintings equally as to men, and consequently indicate lines and shades capable of being copied and systematised. The physiognomist is he who does this with more precision than common observers.

forehead. The forehead is of a good shape, and ends in eye-brows marked with dark hair, the lines considerably horizontal, and supported by bones which terminate well at the temples, and moderately well at the nose. The eyes are dark, and marked with intelligence (that is to say), by the proximity of the edge of the lid to the line of the eye-brow; the line or indenture proceeding from the nose along the upper part of the eye-lid; and other general circumstances, particularly the steady, lively look, and brisk voluntary changes of position produced by the muscles of this organ and those of the neck, at intervals moderately remote. The nose terminates well above, its profile very slightly hooked, the holes large, and the mouth habitually closed. The prominences or lines from the sides of the nose across the cheeks and the neighbouring parts are of the figure which accompanies a placid, affectionate disposition. This is confirmed also by her manner of crying. When she cries from pain, vertical wrinkles appear between the eye-brows; but when from affront, or external inconvenience, the corners of the mouth are depressed. In neither case does she exhibit rage, unless in the extreme of the latter. The lines of the mouth, which is mederately wide, are marked and distinct, and the muscles very accurately disposed to feed either by a vessel or the breast. She fed eagerly and plentifully at fifteen minutes old.

Hence I infer, that she has more than the middle degree of understanding, and is of a calm, placid, though lively and susceptible disposition.

So far proceeds my first note. The others are dated in days of the age of the infant, and relate to points on which Rousseau, and other authors of repute, have written ignorantly. I shall make few remarks, but copy without amendment.

First social acts of infants' attention to the voice.

Second day. Exercise of the hands, legs, and eyes, first engage the attention of infants. By talking in a tone rather musical and uniform, with repetition of the same syllable, and occasional variation, her attention is so much engaged, that she suspends the play of her limbs, and listens very attentively. This was done so frequently in the course of the day as to render her very lively,

lively, and irritably attentive to surrounding objects. It was necessary to give her one drop of tincture of opium, which restored the usual state and disposition for repose.

Voluntary vision.

Fourth day. She can follow an object with the eyes, when her attention is excited, and now and then unequivocally smiles during her observations on surrounding objects.

Expression of pleasure, and articulation.

Fifth day. Her pleasure at viewing luminous and other objects is expressed, not only by the general features, but by efforts of the mouth, protruding the lips, advancing and withdrawing the tongue. She has once or twice pronounced the usual first voluntary articulation of infants, *ku* and *ac-ku*. She is very attentive to language, and answers with smiles, terminating in the word *ac-ku*, and a lively exertion of the legs. She has, apparently for the first time, began to attend to the adjustment of the optic axes, and probably the concomitant focal adjustment of the eye. She is delighted to lie and contemplate the breast at a little distance, after having satisfied her appetite. In this position, as well as when attentive to the kind countenance of the parent who speaks to her, the mouth is protruded and occasionally modified to the indication of pleasure resembling the action of sucking, and all adjustments of the optical axes are tried, from squinting, to the usual very regular position of the eye*.

Optic axes adjusted.

Notion of falling.

Sixth day. The habits of attention, and answering by smiles, by attempts at articulation, and by muscular exertions, are so much strengthened to-day, that the recurrence of those effects is now very frequent. This day she has first betrayed an apprehension of want of support, or, as it is commonly called, fear of falling. Whether this be an acquisition from improved powers of observation, or the consequence of some accidental shock, I am at a loss to conjecture.

* Since the time above referred to, I have witnessed a much earlier voluntary use of the eyes, in another infant. Before the end of the first hour after birth, her attention being directed to a window, she cried from displeasure at its being shut, and ceased upon its being again opened; and she not only followed my hand with her eyes, when moved before them, but altered the positions of their axes accordingly as the distance of the hand was varied.

Seventh

Seventh day. The disposition continues, to open the arms and cause rigidity in the system by universal muscular exertion, when suddenly removed in the perpendicular, or likely to fall from support at too small a surface. I think she begins to know her mother independently of smell and the habits of contact, which infants certainly exercise, and distinguish much earlier. She also knows me so far as to attend to my voice and actions much more immediately and steadily than to the nurse, and her sisters.

7th day. Distinguishes persons.

Eighth day. She employs herself very actively in pursuing the objects in the room as they pass her in the relative motion from carrying her about. She seems much more conscious of the optical change of position, than of the progressive motion she herself undergoes. I incline most to the opinion that she has no notion at all concerning it. The novelty of using the hands automatically, or by mere opening and shutting, has for some days gradually worn off, and she now uses them with somewhat more of intelligence, and less incessantly. This day she used the finger and thumb alone; but all by mere contact, not in the least in conjunction with the eyes.

8th. Looks after objects.

Use of the hands by feeling only.

She looks very directly and steadily at objects. While she was lying on the nurse's lap, with her eyes steadily fixed on my face at the distance of three feet, and her countenance expressive of pleasure, I altered my position with various degrees of suddenness and distance on the one and the other side. She immediately pursued me with her eyes, and observed me with the same apparent precision as an adult would have used.

I have not observed her squint since the fifth day. I am disposed to think she does not yet feel the necessity of focal adjustment. Variation of angular position is to her much more striking than mere approach and recess. I have not seen her vary the situation of the optical axes from actual change in the distance of the objects she attends to.

Ninth day. She certainly knows her mother and me, and regards us differently. Ideas of enjoyment, comfort, refreshment, are probably associated with the voice, actions, and figure of her mother. Ideas of mental entertainment

9th. Clear distinction and preference of persons.

tertainment or amusement with me. Her mother's presence seems to excite affection; mine, gladness. When affronted by dressing or undressing, she will cease her cries to listen to the phrases of endearment she is used to hear from me.

10th. Focal adjustment of the eye.

Tenth day. The hand was moved crosswise before the infant at three feet distance, who soon fixed her attention upon it. It was then held still, but the finger and thumb gently opened and shut, to prevent her from withdrawing her notice. Under these circumstances, the hand was gradually brought nearer to her face, and she undoubtedly adjusted the optical axes to the several distances.

This trial was several times repeated in the course of the day, with the same event. When the finger and thumb were brought within the limit of distinct vision on one occasion, the effort of squinting was so disagreeable to her that she shut her eyes, and by a slight exertion or shake of the head, resisted the habit she had been betrayed into. I did not think fit to irritate her by repeating the solicitation. Hence it appears, that she has acquired the adjustment of the eye for distance, though, perhaps, she may be very careless or indifferent about exerting it.

Tremulous motion of the chin.

Yesterday and to-day she has had, at times, a quick involuntary shivering of the chin, very common to infants, but which I do not understand. I think it occurs when her mind is intent upon articulation. It may, perhaps, arise from an indistinct voluntary muscular exertion, or, perhaps, be merely automatic.

11th. First connection of the senses of contact and sight.

Eleventh day. Though she improves daily in the use of her hands, she has no notion of connecting the senses of touch and sight, except with regard to the breast. She sucks for a time, and when satisfied, she makes alternate trials of touch with the mouth, and withdrawing to contemplate the breast by sight.

Fear from sounds.

She has a strong association of danger with sudden or strange sounds, or perhaps the sounds themselves are irritative and unpleasant.

12th. Calm contemplation of remote objects.

Twelfth day. Distant and motionless objects now engage much of her attention. She contemplates them for a time,

a time, and then changes her object, as if reflecting and comparing. But her manner differs greatly, accordingly as she is more or less thoroughly awakened or attentive. The indolent enjoyment of mere sensation is probably the state of all minds not roused by motive. She is much more calm and indifferent, and her apparent progress less rapid, than when every thing was a novelty to her. It gives her more pleasure to see me at the distance of five or six feet than at the old distance of three. She will attend to my talk, but cares much less for me than before. She views her mother with the most lively affection. Though she is more comfortable and happy in my arms than when with any other person but her mother, yet she now very much prefers her mother to me; which she did not at first.

Infants smell very acutely; but do not distinguish tastes at first.

Contrary to an assertion of Rousseau in his Emilius, the sense of smelling in this, and other infants in general, is very acute. They even suck the breast at first by an action of the nostrils, like that of a scenting dog. But the sense of taste is not originally very acute. Medicine, food, and the milk, are then almost indifferently taken. But this infant, at present, prefers the breast very much to water-gruel, and rejects a mixture of rhubarb, chalk, and ginger, with abhorrence.

Concluding remarks.

I shall here suspend my journal for the present, which I am inclined to suspect will be read with some surprise by those who have indolently adopted the opinion, that infants of much more advanced age than during the first fortnight possess very little sense, or moral discrimination. If the contrary opinion, or the truth, were adopted, it would conduce much to the general sum of the happiness of these little beings, who are exerting their industry and diligence in acquiring ideas and language to a degree which is seldom suspected. Others may, perhaps, suppose extraordinary acuteness in the parent, or uncommon ability in the child, to afford an history of its progress during so few days: but here also there would be error. The child is indeed above the middle rank for memory and intelligence, and the father is capable of observing facts and writing them down. But I have never yet met with an infant who would not willingly enter into conver-

The preceding narrative not at all extraordinary.

sation to the extent of its acquisitions and ability, and to the great surprise and diversion of the parents, who never imagined any such thing. Persuasion; promises; lies; meum and tuum; individual character, as to benevolence or its reverse from physiognomy, and as to morals from the behaviour; preference of other infants from similarity of action; jests; mockery; theatrical simulation in the management of dolls, puppets, &c. &c.—these, and a prodigious number of other compound associations, occupy the minds of infants long before the expiration of the first six months of their existence.

I remain, Sir,

Your constant reader,

R. B.

VII.

Repetition of the Experiment in which Acids and Alcali are produced in pure Water by Galvanism, (no Animal or Vegetable Matter, nor Oxidable Metal being present) by Mr. Charles Sylvester.

Mr. Nicholson.

Sir,

Experiment of the production of alcali, &c. from water by galvanism is referred to.

In your number for June last, I communicated some experiments tending to prove the production of the muriatic acid and an alcali, from pure water, by means of galvanism. I had not then an opportunity of giving you the whole of the experiments I had made in this dubious research. The first way in which I made the experiment was by bringing two wires of platina, or gold, from the two ends of the trough into a portion of pure water in one vessel, but I never produced the smallest quantity of muriatic acid. I am not surprised at Mr. Wilkinson's finding the same result.

Muriatic acid cannot be produced in a single vessel.

Mr. Peel and Mr. Pachiani made their experiments in the same way, and it is my opinion they never produced the muriatic acid, nor an alcali.

But the experiment succeeds with separated

If each of the platina wires be made to terminate in a separate portion of pure water, and these portions of water be afterwards connected together by an animal substance,

tance, or any substance containing moisture, the experiment will succeed. In my first attempt by this method, I separated the two portions of water by means of a bit of very thin bladder, which was tied tight upon the end of a glass tube, the tube was filled with pure water, which the bladder did not suffer to escape. Another portion of water was put into a wine glass, the tube was then immersed into the water of the wine glass, with the bladder downwards. The two portions being now separated by the bladder, the positive wire was brought into the tube, and the negative one into the wine glass. If with a moderate sized apparatus the process be continued for even half an hour, a perceptable quantity of muriatic acid will be found in the water of the tube, and a portion of fixed alcali (I believe soda) in the wine glass. I repeated this experiment more than thirty times with the same piece of bladder, and had always the same result. Though I was at the time perfectly satisfied as to the production of an acid and an alcali, I still thought, consistent with your query in the margin, that the bladder might have contributed to the production of the acid. But from whence came the fixed alcali? a very ingenious chemist who has made the same experiment, says it comes from the glass vessel; the thought appears very plausible, but I believe it is not a fact.

vessels connected by animal substance.

If the acid be afforded by the animal substance, whence comes the alcali

From the glass?

Consistently with my promise to you, I have made the experiment without the aid of either animal or vegetable substance to separate the two portions of water, and instead of a wine glass, I made use of a platina cup.

Experiment repeated without any organized matter.

In order completely to exclude glass, I got a tube made of tobacco-pipe clay, being closed at the bottom, and capable of holding water. The tube was burned in the same furnace with a quantity of tobacco-pipes and was extremely hard. In the first place I suffered the pores of the tube to be saturated with distilled water; I then filled it with the same and fixed it in a platina cup, also containing pure distilled water. The platina cup was placed upon the copper end of the trough, a platina wire reaching to the bottom of the tube was then connected with the zinc end. In a little time bubbles were copiously given out from the bottom of the cup, and also from the

With a tube of baked clay and a cup of platina.

The experiment succeeded and muriatic acid and an alcali were produced.

wire in the tube. In ten minutes from the commencement, the water in the cup was so changed as to be capable of turning yellow turmeric paper, brown; the water in the tube betrayed at the same time the presence of an acid. After the process had gone on for about four hours, I tried the acid part with sulphat of silver, and had a decided precipitate of muriat of silver.

The alcali was a fixed alcali.

The liquor in the cup containing the alcali, I then evaporated to dryness, and afterwards heated the cup nearly red hot; a residuum remained in the bottom, to which I added fresh distilled water. I found the alcali still present; a proof that it is a fixed alcali.

Inferences that the nitric and muriatic acids and all the alcalis are oxides of hydrogen.

In this experiment the alcali was much more abundant than the acid. I have seen in other experiments the acid most predominant; sometimes the nitric acid is formed, and little or none of the muriatic. From the above facts it would appear that the nitric and muriatic acids, as well as the three alcalis are oxydes of hydrogen. At the positive wire, a portion of water is decomposed, the nascent oxigen combines with a portion of water, and forms the nitric or the muriatic acid. The hydrogen is then carried by the electricity, through the bladder or other substance to the opposite wire, where the nascent hydrogen combines with a portion of water to form the alcali, so that the muriatic acid would be water, plus oxigen, and the alcali would be water, plus hydrogen. Hoping that some of your ingenious correspondents will soon confirm these facts,

I remain, Dear Sir,

Your most obedient servant,

CHARLES SYLVESTER.

26, Noble Street, Cheapside,
August 19, 1806.

VIII.

Experiments and Observations on the Adhesion of the Particles of Water to each other. By BENJAMIN, COUNT *of* RUMFORD, *F. R. S. &c. Communicated by the Author to the National Institution of France, and transmitted by him to the Editor.*

Small bodies of considerable

WE often see small bodies of a specific gravity, much exceeding that of water, float upon the surface of that

fluid. Such for example, are very small grains of sand, fine filings of the metals, and even small sewing needles.

specific gravity may float on water.

So extraordinary a phenomenon has not failed to excite the attention of philosophers. It formed a subject of discussion at the last sitting of the Class, and as this remarkable fact is intimately connected with a subject of research upon which I have been long employed, I shall here give an account of some experiments I have made to elucidate the same, and have afforded results of considerable interest.

This effect attributed to air.

Suspecting that the presence of air adhering to these small floating bodies, which is generally considered as the cause of their suspension, is not indispensably necessary for the success of the experiment, I made the following:

EXPERIMENT I.

Ether was poured upon water. Small bodies descended through the ether and floated on the water.

Having half filled with water, a wine glass one inch and a half diameter at its edge, I poured on the surface of the water a stratum of sulphuric ether, one inch and a half in thickness; and when the whole was perfectly still, I took a very small sewing needle with a pair of pincers, which I introduced below the ether, where holding it horizontally at a small distance from the surface of the water, I let it fall. The needle descended to the water and there floated on its surface.

EXPERIMENT II.

Granulated tin descended through the surface of the ether and rested on that of the water.

Having melted some tin I poured it into a spherical wooden box, and shaking it strongly, the metal in cooling was reduced to powder which was then sifted.

On examining this powder with a magnifier, it appeared composed of small spherules of different sizes; but these spherules were too small to be distinguished by the naked eye.

I took up on the point of a spatula a very small quantity of this metallic powder, and poured it gently from the height of a quarter of an inch on the surface of the ether which rested upon the water in the glass.

The powder descended wholly through the ether, and when it arrived at the surface of the water, it remained floating.

EXPERIMENT

EXPERIMENT III.

The same experiment with small globules of mercury.

Having poured a large drop of mercury into a china plate, I broke it into a great number of small spherules.

In order to take up and convey these small spherules one by one, I made a small tool or shovel out of a piece of brass wire, five inches long and about one twentieth of an inch in diameter, bended to a right angle at one of its extremities. This bended part was about a quarter of an inch long, and was hammered flat, sharpened, and made a little concave.

By means of this tool I took up a small spherule of mercury, about one sixtieth of an inch diameter, which I carefully conveyed into the stratum of ether to the distance of about one twentieth of an inch from the surface of the water beneath; and there, by a little inclination of the instrument, I caused the spherule of mercury to roll gently on the surface of the water.

The spherule descended to that surface and there remained floating.

The floating heavy body formed a kind of bag or cavity in the surface of the water.

When the eye was placed lower than the surface of the water, and the spherule was observed by looking upwards through the glass; it appeared suspended in a kind of bag, a little below the level of the surface.

Having placed a second spherule of mercury on the surface of the water, it immediately moved towards the former, and approaching it with an accelerated motion, fell down into the same cavity, which then became longer; but the two spherules did not unite.

Having placed a third spherule on the surface of the water, it joined the two others, but the weight of these three spherules together being too great to be supported by the kind of pellicle which is formed at the surface of the water, the bag was broken, and the spherules descended through the water to the bottom of the vessel.

—which breaks when the body is too heavy,

When the experiment was made with a spherule of mercury, a little larger, namely about the fortieth or fiftieth of an inch, it never failed to break the pellicle of the water, and to descend through that liquid to the bottom of the glass. But when the viscidity of the water was increased by dissolving a small quantity of gum arabic in it, still larger spherules of mercury were supported at the surface of the liquid.

A spherule

A spherule of mercury of a proper size to be supported by water, at its surface, if placed gently there, would not fail to make its way through the pellicle of the water, if let fall from too great an height.

or let fall from too great a height.

All the preceding experiments were repeated with a stratum of essential oil of turpentine, and afterwards with one of oil of olives, placed on the water contained in the glass instead of the ether, and the results were in all respects similar. I thought however that the spherules of mercury which were suspended upon the water were rather larger when the surface of the water was covered with oil than with ether; and in the experiments made with the powder of tin, poured on the oil, the finest parts of the powder, in very small quantity, floated on the surface of the oil.

The experiments answer equally well when oil is poured on the water instead of ether.

EXPERIMENT IV.

Having found means to place a stratum of alcohol on the water contained in the glass, so that the two liquids appeared as distinct from each other, as when the upper stratum was oil, I poured from a very small height a small quantity of the very fine powder of tin upon the alcohol.

With alcohol the bodies do not float,

This powder totally descended through the alcohol, and the water, without giving the smallest indication of its having been subjected to any resistance at the surface of the latter fluid.

Though this last surface appeared very distinctly to the eye, yet judging from the manner in which the metallic powder descended to the bottom of the glass, I am disposed to think that it had no existence; and in fact it is probable that it was destroyed by the chemical action of the alcohol in contact with the water.

In order to examine more accurately the kind of film which is formed at the surface of the water, I made the following experiment:

EXPERIMENT V.

In a cylindrical glass with a solid foot, the diameter of which was fourteen lines or about an inch and a half English, and ten inches in height, I poured very limpid water to the height of nine inches, and on the water I placed a stratum of ether, three lines or twelfths of an inch

When the first experiment is made with a glass of small diameter, the effects shew that a kind of

film exists at the surface of the water.

inch in thickness. I then placed on the surface of the water, a number of small solid bodies which remained suspended, such as a small spherule of mercury, some pieces of extremely fine silver wire, two or three lines in length, and a little of the powder of tin. When the whole was perfectly tranquil, I took the glass in both hands, and carefully raising it, I turned it three or four times round its axis with considerable rapidity, keeping it in a vertical position. All the small bodies suspended at the surface of the water, turned round along with the glass and stopped when it was stopped: but the liquid water below the surface did not, at first, begin to turn along with the glass, and its motion of rotation did not cease all at once upon stopping that of the vessel. In fact, all the appearances showed that there was a real pellicle at the surface of the water, and that this pellicle was strongly attached to the sides of the glass so as to move along with it.

—which being touched all the floating bodies tremble.

Upon examining with a good magnifier through the stratum of ether, the small bodes which were supported at the surface of the water, the existence of this pellicle could no longer be doubted; more particularly when it was touched with the point of a needle. For in this case all the small bodies were observed to tremble at the same time.

Having left this small apparatus at repose in a quiet chamber until the stratum of ether was entirely evaporated, I examined it again with a magnifier. The surface of the water was precisely in the same state; the small solid bodies were still there, in the same situation, and at the same distances from each other.

With a larger vessel the film near its centre is less affected by its adhesion to the sides.

When this experiment was made with a cylindrical glass of much larger diameter, the effects of the adhesion of the pellicle of the water to the sides of the vessel, were much less sensible, with regard to those parts of the same which were situated near the axis. It was difficult to prevent the small bodies which floated on the surface of the water, from uniting, and when united they often formed masses too heavy to continue to be supported; and having broke the pellicle of the water, they fell to the bottom of the vessel.

[The Conclusion in our next.]

IX.

Experiments on the Culture of Carrots. By Mr. W. WALLIS MASON.*

SIR,

THE purport of this communication is to explain with a degree of accuracy, the general, and as far as possible the best method to cultivate carrots. I shall therefore endeavour to set aside those prejudices, which frequently occur in every branch of agriculture; while I give a brief statement of particulars, which experience, assisted by numerous comparisons, has induced me to consider as best for adoption for rearing the plants, as well as most judicious in the application of the vegetables when cultivated. In Suffolk, the culture of this highly valuable root has been carried on for ages; but of late years it has very much increased, and furnishes the best criterion of its worth; various have been the attempts to extend the benefit more generally throughout the kingdom, but with little success; imaginary difficulties arising in the minds of cultivators, which I hope to obviate by a more minute detail, the observance of which will enable any practical farmer, on a proper soil, to raise a crop, which will at once be productive of great private advantage and public utility. On most farms it will be found, that a considerable proportion of the produce from the best land (the meadow and upland pasture) is consumed by the laborious cattle, and the lean and rearing stock during the winter months. The carrot system may be carried on, on inferior arable lands, and the produce, by judicious application, will be found to excel far

The carrot is much cultivated in Suffolk.

* From the transactions of the Society of Arts, Vol. XXIII, just published. The Society awarded the Silver Medal for this Communication.

It requires only inferior lands.

far beyond general expectation that of the grazing land, which will in consequence be appropriated to great national advantage, by furnishing an additional supply of animal food, of wool, and the produce of the dairy.

Preferable Soil.

A red loamy sand is at all times to be preferred, as free from stones as possible; but very large crops may be grown on any land, which is not of a too tenacious or binding quality, with sufficient depth of soil.

To be ploughed deep.

In order to increase the luxuriance of the root, it is necessary to remove the soil to the depth of 14 inches: this is easily accomplished, by first ploughing the furrow seven inches deep in the usual manner, then follow with the second plough in the same furrow, which, by the assistance of an additional horse, brings up the soil from the depth required. The first plough continues to turn the fresh furrow to the bottom of the double furrow, and being followed by the double furrow, as in the first instance, the soil becomes completely mixed and ready for the reception of the seed.

The first furrow is seven inches deep, and is removed into the ....
second furrow, of fourteen inches deep; this in rotation becomes the first stratum.

The lands, or stitches cannot be too wide, from 18 to 25 yards.

It is necessary to observe, the land at all times on which this crop is intended to be produced, should be in a perfectly clean state; a barley stubble which succeeded a fallow, &c. Yet few crops turn out more productive than those cultivated on clover, or lays of artificial grasses; ploughing the same as on a barley stubble.

Sowing to be immediately after ploughing.

A rule which in most instances holds good, must not here be neglected, that of getting in the seed directly after the ploughs; a neglect of this would be attended with the worst consequences; on stale land the weeds would, in a short time, completely get the better of the young plants, and thereby occasion a great deficiency in the crop.

Five

Quantity of Seed per acre, &c.

Five pounds of seed is commonly sown per acre; but as its value, comparatively speaking, is very trifling with the advantage of a good plant, I never recommend less than six pounds per acre. In a dry season there is a great benefit in steeping the seed for twenty-four hours; to prepare it for the drill, or for sowing, it should be well rubbed with the palm of the hand against the side of a tub, to destroy the small fibres and prevent their adhesion, and a proportion of fine sifted marl and saw-dust mixed with it; the proportion two-fourths marl, one-fourth saw-dust, to one-fourth of seed.

Drilling is indubitably the best way to get in the seed, from six to nine inches asunder: the advantage is obvious: the carrots stand the winter much better: from the tops of the vegetables being nearly buried in the soil, the green head only is visible to the eye, and it is very rare to see the smallest part of the red carrot above the surface. An additional advantage in this mode of cultivation, is the great facility it furnishes in weeding and hoeing, which, in a district not hitherto acquainted with this useful branch of agriculture, must render it in a twofold degree desirable.

Carrots in the early state are very tender plants, and very slow in growth; I have frequently noticed a field scarcely visible to the eye, three weeks or a month after sowing, which has turned out a most abundant produce. It is frequently six weeks before they are fit to hoe; but to prescribe any rule is impossible, since the vegetation of every description of plants so much depends on the season. I shall only observe, the most proper time to commence weeding or hoeing, is soon after the plants gain the parsley leaf, or about half-inch out of the ground. Every vegetable intended to be thinned or separated by the hoe, cannot well be done too early, since from general observation it is clearly ascertained, that the smaller the plants, the greater is the number left; and as a second hoeing is absolutely necessary (if it is only to promote vegetation by loosening the surface), the plants may then be distributed as requisite. In hoeing of every description, it is always necessary to stir every part of the soil possible; in this instance it must on no account be neglected.

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The season for sowing, is from the middle of March to the 12th of April. In dry weather it is best to leave the seed rolled down. The land should always be harrowed after drilling or sowing; from the nature of the plant, a pulverization of the soil is requisite. It is, however, useless to detail particulars of this sort, which must in so material a degree depend on the state of the season, in which the judgment of the practical farmer cannot easily fail; suffice it to say, the lighter, the finer, and the less binding the soil, the better vegetation must flourish.

With respect to the best method of cleansing the young crop, I have only to observe, that nine times in ten it answers better to weed by hand, than to hoe the first time; this rests on a supposition, that the crop is much encumbered by weeds; on the contrary, (which is rarely the case) supposing it perfectly clean, the hoe will answer every purpose requisite. There is great judgement to be observed in the first hoeing, particularly to leave the plants sufficiently thick, and not to bury them in the process; should this be done, your fairest prospects will at once vanish. The women and children employed to weed, should not be suffered to pull a single carrot plant; the hoe effects the purpose of setting out in a superior manner, and should within two or three days follow the weeders. I have frequently seen the land so much covered with weeds, that the plant of carrots was extremely doubtful; after hand-weeding, a very good plant was seen, which would have been destroyed in great measure, had the hoe been previously used. One weeding and two hoeings are generally sufficient; by the time they are accomplished, the carrot-tops generally are of sufficient growth so shade the land. The proper hoe, to be made use of should be 4 inches wide, by $1\frac{1}{4}$ inch high, and always kept very sharp.

Carrots, like turnips, and other vegetables intended to be housed for winter, should not be taken up before they are full grown; they never answer better than when used from one to four weeks after they are out of the ground. They are little liable to injury in winter; the latest time for taking

ing up, is just before the fibrous roots begin to shoot in the spring; at which period the vegetable becomes less nutritive, at the same time injurious to the land.

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By these attentions I have invariably found the cultivation of carrots extremely beneficial to the land, and not unfrequently the value of the crop equal to the fee-simple of it. The greatest produce I ever remember was eighteen loads per acre, forty heaped bushels to the load; yet I have heard of much larger crops.

Worn-out ploughed lands are renewed by the intermixture of fresh soil occasioned by the deep ploughing; and the proof is visible in many succeeding crops of corn, grasses, &c.

The same land will produce very good crops of carrots for years in succession; but in this instance manure becomes necessary. They are taken up with a narrow spade, which the labourer strikes with one hand into the ground, pressing it sideways at the same time; he draws the root with the other, throwing it to the heap, where sits his wife and children to cut off the tops: the tops are left and spread as manure to the land.

Expences of Labour.

	s.	d.
Weeding varies from 5s. to 10s per acre, average	7	6
First Hoeing	7	0
Second do.	5	6
Taking up per load, and topping	1	2

Observing these prices, it is necessary to remark, the labourers, in dear seasons, have an allowance for flour.

To every single man one stone of flour per week, the master paying the additional price above two shillings per stone.

To a man and his wife one stone and a half per week, and half a stone per week to every additional child under twelve years old, at which time they are deemed capable of earning their own bread.

By the introduction of this judicious plan, the labourer shares the benefit of that grain which his own industry had helped to cultivate, and feels but in a small degree the oppression

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pression of the times; the interest of the master and the servant becomes reciprocal, for the price of labour continues nearly at the usual standard; had it been otherwise, the farmer must have suffered when his commodities became of less value.

The annual rent of those lands on which carrots are generally grown, is from 5s. to 20s. per acre; but I have invariably found the profit by far the greatest when the best soil has been made use of :—

A good crop on land worth 5s. per acre	7 loads,
——— on land worth 10s. per acre . . .	9 do.
——— on land worth 15s. per acre . . .	11 do.
On the best land, as I before remarked	18 do.

The advantage in preferring good land is obvious, the chief expences being nearly the same as on poor soil; the additional labour consists chiefly in taking up.

Carrots are sometimes sown when the land has received but a single furrow, a sure badge of indolence. The annexed Drawing is to prove the necessity of deep ploughing, by means of the double furrow. *Fig.* 1. is the shape and comparative size of a carrot grown on a single furrow; the earth below where the soil was stirred, acting as a repellent, checks the growth of the root, and causes it to shoot laterally.

Fig. 2, is the comparative growth and shape of a carrot grown on the double furrow.* On all soils which are adapted to this branch of husbandry, the first ploughing may be done by a pair of horses abreast; the lower, or double furrow, by three horses abreast. The nearer the cattle are to the work, the greater the purchase; they labour with greater spirit in sociable pairs than in a drone-like string at length.

It is a common custom with the cultivators of carrots to raise their own seed: it requires little attention, and the

* We have not copied the Author's drawings. They shew that the carrot in the deep furrow shoots downwards to a greater distance, so as to be half as much more in size than the other. Editor.

crop

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crop is seldom known to fail.—For this purpose choose such carrots as are in no respect injured by frost; and the handsomest of a middle size; trim the green top, leaving about an inch of it, and cut two inches off the extremity of the root. Plant them in double rows, a foot wide, and six inches in the row; the interval of the double rows three feet: this is requisite, as the seed does not ripen together. The path or interval serves to gather the seed, which must be done daily as the heads of seed arrive at maturity: it is frequently three weeks before the crop is cleared. Spread the heads of seeds to dry on a floor, or in dry weather on the ground; afterwards separate the seed from the stalks with a comb. The season to plant carrots for seed, is the latter end of February or the beginning of March, when the severe frosts are over.

Having explained, in as concise a manner as possible, what is necessary to be observed, to enable the practical farmer to cultivate this highly valuable root, in districts hitherto deprived of the great benefit it affords to the community, and the great profit to the cultivator, free from all theoretical and speculative opinions, I proceed to a short detail of the use and application of carrots when cultivated. On their utility for family consumption, it will not be necessary to dwell; I have therefore only to remark, since vegetables are found to be more or less nutritive in proportion to the saccharine matter they contain, but few vegetables will be found to excel them. I have known large crops of carrots sold, for the London market, at forty shillings per load, delivered at a port four miles distant from the land, which produced them a price for which a ready sale will be found in any populous town, during the winter season: for this purpose they should be assorted; all the overgrown and crooked ones reserved for home consumption, for which they will answer as well as the others; and when topped, half an inch of the green crown left on: for this purpose they are not usually washed. For home consumption I have invariably found them to answer best for the use of cart-horses; when designed for the food of other cattle, of any description, the green top must

Experimental Instructions for the Culture of Carrots

must be entirely cut off, and the carrots washed perfectly free from dirt and sand. It is necessary to house them three or four days at least before horses are fed with them; a neglect of this is sure to be attended with dangerous consequences. It is generally known that the cucumber when left a short time in water, absorbs a proportion of it; the carrot does the same, in a less degree, yet sufficiently to produce a considerable degree of fermentation by the heat of the animal's stomach; and griping is occasioned thereby. To render them salutary, the time mentioned is sufficient for evaporation.—Washing is easily and expeditiously done, by putting a large mash-tub three parts full of carrots, then pouring cold water on them, stir them, and throw them out with four-pronged muck-forks; after which process they may be laid under cover in large heaps, as much as six or eight loads in a heap; secured from frost and rain, they will keep two or three months; it is however not right to suffer them to remain so long, in which case they shrivel even to two thirds of measure; and although they become more nutritious, from the loss of aqueous particles, it is not sufficient to compensate the deficiency. Carrots are extremely valuable when applied as food for cart-horses: when properly fed with them, they are in the greatest vigour and health; and their coats are as fine as the best-groomed coach horses, even in the depth of winter, and exposed to the inclemency of the season in a straw-yard. For home consumption, I have in-invariably found them to pay more, by one-third, when given to horses, than to feeding cattle. After a variety of experiments, I have found the following manner of applying them to be the best:—To each cart-horse, one heaped bushel per day, with as much cut provender as he could eat; the latter should be of the first quality. I recommend two-thirds good wheat or oat straw, and one-third clover. Wheat straw is best; oat-straw next. Barley-straw is frequently given, but never preferred, from its griping tendency. Horses cannot eat too much cut food. When returned from work, they should always be baited with it, or drink their water before carrots are given, and plenty of dry food given with the carrots: the dry nature of the one

corrects

corrects the cold quality of the other. There is not any occasion to cut the carrots, but to mix them with the cut food, and feed them in the manger. Horses used to carrots will prefer them to oats, when given together. If the straw and clover are not of the first quality, oats should be given in proportion. By this method of feeding, there is a saving of at least two thirds of the hay usually consumed; corn is dispensed with; and horses will be in a better condition than when fed with hay and corn only, supposing each horse is allowed with hay half a a peck of oats per day.

Experimental Instructions for the Culture of Carrots.

Great care must be taken never to give carrots when horses come to the stable heated by work.

Carrots are not proper food for riding-horses; nimble exercise causes them to be laxative; and as they will sometimes produce griping, I shall insert a prescription which has been proved by long experience, together with the treatment to be pursued in such cases.

Oil of Turpentine	1 oz.
Castile Soap	1 oz.
Flour of Mustard	$\frac{1}{2}$ oz.

On the first symptom this mixture should be given, and it will not fail to remove the complaint. The Castile soap to be cut fine, and dissolved in a quart of boiling water, the mustard added; the oil of turpentine the last thing; it should be given more than milk warm; if the animal suffers much pain, add half an ounce of liquid laudanum. On the first appearance of the disease, the horse should be well coated, and constantly rubbed with hard twisted wisps of straw, and kept as warm as possible; should the disease increase, and the body swell much, a gallon of blood should be taken, to check the inflammation, and give time for the medicine to operate. If the symptoms increase, repeat the dose, omitting the liquid laudanum. Clysters and raking afford much relief when the symptoms first appear, and frequently remove the complaint.

Feeding cattle improve more on carrots, than when fed with potatoes or turnips; they are excellent food for ewes at

Experimental Instructions for the Culture of Carrots.

at lambing time, and should be cut, or they are subject to break their mouths.

Store pigs may be fattened on carrots only, and large hogs feed remarkably well, when fed with half corn and half carrots.

Heifers in calf, which require good keep and calve early, thrive better on carrots and good oat straw, than on hay only—one bushel of carrots per day—care must be taken not to give them too early or too many; in which case, the calves are liable to overgrow.

Weaned calves thrive well on this food; a peck per day is quite sufficient, more would increase the body too much.

Milking cows give more milk on carrots and straw, than on hay only. In all these instances their superiority is more, comparatively speaking, than the difference of a carrot crop rated at one guinea per load of forty bushels, to the value of turnips on the same soil; rating them as a produce for home consumption.

One heaped bushel of carrots, therefore, is equal to 18lbs. of hay. Admitting each cart-horse to consume this quantity of hay for 120 days, it amounts to 2,160lbs. the average produce of one acre of good pasture land.

The same animal, if fed on carrots, with the addition of the cut-straw provender, which is a substitute for corn, and adds solidity to the carrots, will require only 120 bushels of carrots, or three loads; not half the produce of an acre of arable land worth 5s. per acre.

To this must be added the great superiority in point of condition, which the cattle evince. The latter method of feeding with carrots and cut provender, is fully equal to 18lbs. of hay and half a peck of oats to each horse.

My object in presenting the above remarks, ~~for the~~ consideration of the Society for the Encouragement of Arts, &c. &c. is the hope of extending a most valuable branch of Agriculture (which has long stood the test of experience) more generally throughout the kingdom; and is respectfully submitted to them by their obedient servant,

W. WALLIS MASON.

Goodrest Lodge, near Warwick,
Jan. 31, 1805.

To Charles Taylor, Esq.

X.

Extracts from a Collection of Papers on the Subject of Athletic Exercises. By Sir John SINCLAIR, Bart. M.P.*

This Pamphlet consisting of 100 *pages in octavo, contains a re-print of the Observations which were before circulated by Sir John Sinclair, which were inserted in our thirteenth volume,* p. 309 *to p.* 317, *with the answers which were produced by that interesting enquiry. For the present I shall confine myself to a Letter from Dr. A. P. Buchan, on the manner of treating the Ancient Athletics.*

To Sir John Sinclair, Bart, M.P.

SIR,

My attention having been greatly excited by the very ingenious observations and queries circulated by you, concerning the method of producing, what, perhaps, with propriety, may be denominated the athletic temperament; as well as by the interesting facts contained in the communications of your various correspondents, it occurred to me, that a comparison of the modern art of training, with that practised by the antients, who certainly paid no small attention to the means of augmenting corporeal vigour and activity, would tend to throw some farther light on this curious subject. Advantages of comparing the ancient and modern methods of training.

Among the antient inhabitants of Greece much pains were bestowed in improving the strength and activity of the human body, by due cultivation. The ancient Grecians.

* Printed in London, 1806, and gratuitously circulated by the Author. I would take the liberty to suggest to the honorable Baronet, as well as to all other public spirited writers in like circumstances, that for the purpose of easy and extensive distribution, every book ought to be sold for a price at some known place, and announced once or twice in the public papers. This effectual means of placing a work in the hands of the public by the medium of booksellers, is obviously no impediment to the gratuitous distribution, which may at the same time be carried to any extent desired.

The

Gymnastic exercises.

The gymnastic exercises, so termed from their being generally performed in a state of nudity, constituted among that people an important part of liberal education, and were regularly taught by masters in schools instituted for that express purpose. Pupils were exercised in the foot race, and in the art of leaping, and of throwing the *discus* or quoit, and the javelin. These were considered as the slighter species of exercise. The more serious consisted of the art of wrestling and of boxing The combination of these two was termed *pancratium*, and seems to have been nearly equivalent to the modern English practice of boxing. When it is considered that the man who obtained a prize at the Olympic, the Pythian, or any of the public games, where candidates resorted from all the different states of Greece to contend in these exercises, not only acquired a distinction highly gratifying to himself, but which reflected honor on his family, and even on his country; it may be fairly inferred that every attention was paid to the previous education of the individuals, destined to excel in these exertions of muscular strength. Of the particular diet, and kinds of exercise in use among the Greeks previous to the solemn contest at the public games, I have not been fortunate enough to find any detailed account. Pausanias mentions that ten months previous to the solemn combat, the candidates took an oath in the temple of Jupiter, faithfully to comply with all the antient laws and usages of the champions, and from that time till the period of the solemnity they were daily and diligently exercised in whatever was requisite to produce excellence in the profession to which they had devoted themselves. A proof that the means they employed were admirably calculated to develope and improve all the corporeal powers of the human animal, is afforded by the statues of antiquity. The superiority of the Grecian sculpture, which the world has ever since attempted in vain to rival, was doubtless in great measure owing to the frequent opportunities the artists of those times enjoyed of beholding the human body brought to the highest pitch of perfection, which constant exercise in the open air, combined with appropriate regimen under a genial climate, had a natural tendency to produce. To

Foot Races.

Pancratium or Boxing.

The Candidates were previously educated, exercised and trained

To the individuals who excelled in some particular kinds of exercise, we learn from Pliny, that a statue was decreed as the appropriate reward; so that many of those figures which still remain, that of the *Discobolus*, for example, are in fact, individual portraits; and might almost without a hyperbole, be called living examples of the perfection which the human form is capable of attaining.

The ancient statues were portraits of the improved human figure.

The Romans seem to have derived their inclination for public combats, as they did many other of their arts, from the Greeks. But to engage personally in these contests, appears to have been considered as incompatible with the stern dignity and decorum of the republican character. They therefore hired persons to contend with each other for their amusement. From the victor receiving a prize or reward, they were termed *Athletæ*. But the warlike genius of the Roman people soon led them to require exhibitions of a more sanguinary nature. These were performed by the gladiators, who at first consisted of captives taken in war, who were compelled to fight with each other for the amusement of the populace. Afterwards persons voluntarily embraced that mode of obtaining a livelihood, and hired themselves for money to such as chose to court popularity by treating the public with an exhibition of this kind, of which they had become extremely fond. The gladiators fought with swords and other weapons, and their combats became mortal at the will of the spectators.

Athletæ of the Romans.

Gladiators.

Notwithstanding the degradation of the exercises of the *palæstra* among the Romans from the rank of a liberal art, a certain degree of bodily strength and activity was indispensibly requisite to those by whom they continued to be practised. To acquire this it was requisite to comply with certain rules of regimen and exercise, concerning the nature of which a considerable share of sufficiently accurate information may still be gleaned.

Regimen and exercise.

Horace acquaints us with the kinds of exercise and of privations requisite to fit a person for contending for the prize, even in the least violent of the gymnastic exercises.

> "Qui studet optatam cursu contingere metam,
> Multa tulit, fecitque puer, sudavit et alsit,
> Abstinuit venere et Baccho."

Epictetus

Training for the Olympic games as described by Epictetus.

Epictetus in alluding to the olympic games gives a somewhat more detailed account of the previous training the candidates were obliged to undergo. "I would conquer at the olympic games," he supposes his pupil to say, and then goes on to tell him; But then consider what precedes and follows, and then if it be for your advantage engage in the affair. You must conform to rules; submit to a diet; refrain from dainties; exercise your body whether you chuse it or not, at a stated hour, in heat or cold; you must drink no cold water; nor sometimes even wine. In a word, you must give yourself up to your master as to a physician. Then, in a combat you may be thrown into a ditch, dislocate your arm, turn your ankle, swallow abundance of dust; and after all lose the victory.*"

Galen was a Gymnasiarch.

Galen, the celebrated physician, was himself addicted to the exercises of the *palæstra* in his youth, and has left a detailed account of the pain he suffered in the reduction of his shoulder, which had been dislocated in a wrestling match. He afterwards became a gymnasiarch, or superintendant of a company of gladiators, and many remarks on their diet, exercises, health, and habits are to be found in his writings.

Diet of the Athletæ mostly vegetable.

The diet of the *Athletæ*, in the more early ages consisted of dried figs, new cheese, and boiled grain. The antients appear to have derived a favourable opinion of the nutritious properties of figs, from observing that the persons who were appointed to guard the fig-gardens and vineyards, when the fruit was nearly ripe, and who fed upon hardly any thing else for a month or six weeks, during that period became remarkably fat. Geese were also fed on figs, in order to produce those enlarged livers which constituted a favourite delicacy of the Roman epicures. The fat and sleek appearance which the negroes, and indeed all the domestic animals in the West Indies, acquire during the season of boiling the sugar, notwithstanding the increased labour they undergo at that period, furnishes another proof of the nutritious properties of saccharine matter. It is a fact,

* Carter's Epictetus, Book iii. chap. 15.

perhaps

perhaps not very generally known, that, though a dilute solution of sugar very frequently disorders the stomach, by running into the acetous fermentation, eaten in a dry or solid form sugar hardly ever disagrees.

The governor of a gymnasium, named Pythagoras, is said to have been the first who introduced the use of animal food as part of the athletic regimen, in consequence of having observed that it produced firmer flesh, and gave more real muscular strength. Of meat, the antient *Athletæ* were restricted to the use of pork. Galen asserts that pork contains more real nutriment than the flesh of any other animal which is used as food by man; this fact, he adds, is decidedly proved by the example of the *Athletæ*, who, if they lived but for one day on any other species of food, found their vigour manifestly impaired the next. The practice of the antients differs in this respect from that of the modern trainers, who seem universally to prefer the use of beef and mutton. Perhaps these animals were not brought to such perfection, as the food of man, in antient, as they have been in modern times. The antients occasionally ate goat's flesh, which was reckoned highly nutritious, but it is said to have imparted a most fœtid and disagreeable odour to the bodies of those who used it. The preparation of meat by roasting, or broiling, was universally preferred to boiling, in which process they conceived a great part of the nutritive juices of the meat were lost in the water. Bread made of the whole flour, and unfermented *(panis azymus)* was preferred to that prepared with leaven. I have myself heard a seafaring man observe that he was always sensible of a diminution of muscular strength when he left off the use of biscuit, and ate common bread. For breakfast they took a little dry bread; but after the exercises of the day were over, they always eat to satiety, and were sometimes even forced to gorge themselves with food. Milo of Crotona is said to have consumed fifty pounds of solid food in one day. Their drink was water or some species of thick sweet wine. But they were allowed a very small quantity of fluid. This dry diet seems to have constituted an essential and important part of their regimen.

But latterly animal.

Pork preferred by the antients.

Roasted.

Bread not fermented.

The food in great quantity, but drink sparing.

They

Exercises, anointing, &c.

They were regularly exercised for many hours, daily, in every variety of muscular effort. Before engaging in the combat of the pancratium, or wrestling and boxing, the skin was anointed either with oil, or with a mixture of oil and wax, termed ceroma. This was supposed to prevent too great a loss by perspiration, as well as to supple the limbs, to grapple a man whose skin was covered with an unctuous matter of this kind was impossible; they therefore rubbed thesmelves with the dust that covered the *palæstra.* When people of rank engaged in these contests, they made use of odoriferous unguents, and rubbed themselves with a peculiar kind of pulverable earth brought from a certain cavern near Puteoli, or what was reckoned still preferable, with a kind of dust named *haphè,* which was imported from Egypt.

Refreshment by bathing, rubbing, anointing, food, &c.

When their exercises were finished they had recourse to their *apotherapia,* or methods of refreshment. They were immersed in a tepid bath, where the perspiration and sordes were carefully removed from the surface of the body by the use of the strygil. The skin was then diligently rubbed dry, and again anointed with oil. If thirsty they were permitted to drink a small quantity of warm water*. They then took their principal repast, after which they never used any exercise. They occasionally also went into the cold bath in the morning. They were permitted to sleep as many hours as they chose; and great increase of vigour, as well as of bulk was supposed to be derived from long continued and sound repose.

* Nothing can afford a ſtronger proof of the attention paid by the antients to the effects of exerciſe, than the prohibition of cold drink to perſons who had been thus fatigued. When heated and exhauſted by violent muſcular exertion, it is not only much more ſafe, but even more refreſhing, to take ſome warm fluid, as tea, into the ſtomach, than to drink any cold liquor. Immediate death has not ſeldom been the conſequence of drinking a glaſs of cold water or beer, after having been heated and fatigued by dancing, or any other violent exerciſe. To thoſe who may inadvertently be guilty of ſuch imprudence, it may be well to know, that to ſwallow immediately a glaſs of brandy, or a tea-ſpoonful of laudanum, is the beſt means of counteracting its baneful conſequences.

In

In order to empty the stomach previously to entering on this particular regimen, the ancients appear to have preferred the use of emetics to that of purgatives. Vomiting was produced by tickling the fauces with the finger, or by means of a feather, which was occasionally dipped in a solution of aloes. Stimulating glysters were occasionally administered, and one of these modes of evacuating the stomach or intestines was practised whenever the appetite appeared to flag. Emetics at commencing the course.

Sexual intercourse was strictly prohibited; and during the night plates of lead were worn on the loins, with a view to prevent venereal inclinations. No sexual intercourse.

In order to exercise their patience, and accustom them to bear pain without flinching, they were occasionally flogged on the back, with the branches of a kind of rhododendron, till the blood flowed pretty plentifully. By diminishing the quantity of the circulating fluid, this rough kind of cupping was also considered as salutary, in obviating the tendency to plethora, to which they were peculiarly liable. Flaggelation.

To be exercised in a pure salubrious air was deemed of essential importance. The principal schools of the Roman *Athletæ* were accordingly established at Capua and Ravenna, places, the air of which was reckoned the most pure and healthy of any in Italy. They carried on their exercises in the open air, in all sorts of weather, the changes of which soon ceased to affect them. Salubrious air.

You will probably agree with me in remarking a considerable degree of conformity between the ancient and the modern practice of training, in the kinds of food and drink preferred, in exercise, and in constant exposure to pure and free air; the last point I should consider as being of essential importance.

The antients appear to have paid more attention to the state of the skin, by their use of the warm bath, and of friction. And the adoption of these means would probably be found useful by our modern practitioners. Nothing is more grateful after exertion, or tends to alleviate fatigue more than the tepid bath. I should imagine immersion in warm The ancients used the bath more than the moderns.

 water

water the best mode of averting the injurious effects of a boxing match.

That this regimen and exercise would have the same effects in former times, as in the present day, cannot be doubted. The ancient *cæstus*, which consisted of leathern thongs, studded with knobs of lead or copper, and contorted round the hand, must have added greatly to the force of a blow. These straps were indeed carried up to the elbow, by which the arm was in some measure protected. I doubt, however, whether any of our modern pugilists would venture to encounter such additional means of offence. By the physicians of antiquity the athletic temperament was by no means reckoned a healthy state of the constitution. Hippocrates considered this condition of extreme bodily health as peculiarly prone to disease. Galen, who, as has been already stated, was practically acquainted with the subject, asserts that besides the various accidents to which they were necessarily exposed in the course of their exercises, and combats, the *Athletæ* were liable to rupture of blood vessels in the lungs, to apoplexy, and to lethargic complaints. To obviate the last of which, they were permitted occasionally to have intercourse with the female sex. He says they rarely preserved their vigour so as to be fit to appear in public for a longer period than five years; and he particularly mentions that they were considered as a short-lived race of men. These circumstances are perhaps chiefly to be attributed to their moral conduct. For when not under a course of discipline to fit them for the combat, they indulged themselves in every kind of drunkenness and debauchery; so that by all the authors of antiquity who mention them, their manners are reprobated as being extremely dissolute.

The athletic temparament was not considered healthy.

The athletic were not long lived.

But they lived dissolutely.

Although that state of extreme fulness of blood and high tension of fibre, which is calculated to enable a man to exert his full strength for a short period may not be that condition of the body most consistent with permanent health, or with duration of life, yet I think you have great merit in drawing the attention of the public to the effects of

The treatment might be beneficial if judiciously adopted.

of air, exercise, and diet on the human frame, and demonstrating by such irrefragable examples, the extraordinary alteration which these powerful agents, under due management are capable of operating on the body of man.

The antients were by no means unacquainted with, or inattentive to these instruments of medicine, although modern practitioners appear to have no idea of removing disease or restoring health, but by pouring drugs into the stomach. Herodicus is said to have been the first who applied the exercises and regimen of the gymnasium to the removal of disease or the maintenance of health. Among the Romans, Asclepeiades carried this so far, that he is said by Celsus almost to have banished the use of internal remedies from his practice. He was the inventor of pensile beds, which were used to induce sleep, and of various other modes of exercise and gestation, and rose to great eminence as a physician at Rome. In his own person he afforded an excellent example of the wisdom of his rules and the propriety of his regimen. Pliny tells us that in early life, he made a public profession that he would agree to forfeit all pretensions to the name of a physician, should he ever suffer from sickness, or die but of old age; and what is more extraordinary he fulfilled his promise, for he lived upwards of a century. and at last was killed by a fall down stairs.

The ancients did avail themſelves of this practice to reſtore or preſerve health.

As some of your queries seem intended to obtain information concerning the effects of regimen in removing certain diseased states of the constitution, I beg leave to point out a few examples which have been sanctioned by experience.

Effects of regimen.

Several instances have come within my own knowledge, of individuals who, after having suffered severely from repeated attacks of gout, have completely eradicated that painful distemper, by an entire abstinence from fermented and spirituous liquors of all kinds, and have by the same means recovered a much greater share of health and vigour than they could expect.

Gout cured by abſtinence from fermented liquors.

The effects of the *diæta aquea*, or living wholly on pure water, cooled by ice, in alleviating the pain of cancer, and in several cases even of its effecting a complete cure of that

The diæta aquea, or living wholly upon water, of great advantage in cancer.

painful disease, which are narrated by Mr. POUTEAU*, and which have been corroborated by the experience of that respectable surgeon, Mr. J. PEARSON, have, till very lately at least, been unaccountably neglected in this country. It is a singular fact, that after two or three days the desire for solid food entirely subsided, and the stomach appeared completely satisfied when filled with the aqueous fluid, of which four or five pints were drunk daily The pain of the sore was soon diminished, accompanied with a favorable appearance of the discharge. It is natural to suppose that a person would submit to almost any privation that promised to alleviate the anguish of so distressing a complaint; but those familiar with the manners of the diseased, know how much more readily a sick person will swallow the most nauseous drugs, than agree, to abstain from any of their habitual indulgencies.

Modern instances of the effects of regimen. Cornaro.

The example of CORNARO is the more deserving of attention and imitation, because he adopted a peculiar regimen, in order to effect a specific purpose, in which he completely succeeded. At forty years of age, he laboured under such a complication of disorders, that his life was despaired of. By strictly adhering to a measured diet, he not only perfectly recovered his health, but prolonged his life to more than a hundred years.

Wesley.

The celebrated Wesley is another instance of a delicate constitution, by strict temperance, regular exercise, and early rising, protracting his existence to nearly ninety years.

Wood, the Miller of Billericay.

Mr. Wood, the miller of Billericay, in Essex, whose case is stated in the Transactions of the College of Physicians, London, by Sir George Baker, affords an example of the possibility of reducing, by means of diet, a degree of corpulency, such as to render life a burthen, to a moderate bulk, accompanied with the return of health and strength. The miller's diet consisted of a simple pudding, made by boiling coarse flour in water, without salt. Of this he consumed about three pounds in twenty four hours, and took

* See Oeuvres Posthumes de M. POUTEAU, Docteur en Medicine et Chirurgien en Chef de l'Hotel-Dieu de Lyon.—Paris, 1783.

no

no fluid whatever, not even water. On this he lived in perfect health for many years, went through a great deal of exercise in the open air, and was able to carry five hundred pounds weight, which was more than he could lift in his youth when he ate Animal food and drank freely of Ale.

A gentleman who was fond of good living, and becoming more corpulent than he thought convenient, having heard of the salutary effects of Mr. Wood's regimen, ordered his cook to prepare the Miller's pudding, which he ate with great regularity every day after his usual dinner. However ridiculous such conduct may appear, it is not very uncommon. People should be very cautious how they make any partial change in their diet or habits of living, without adapting the rest to it. Were a person, for example, to adopt so much of athletic regimen as consists in eating to satiety of animal food twice a day, and drinking plentifully of malt-liquor, without augmenting their exercise in the same proportion, undoubtedly they would soon become diseased. Lord Bacon has left us the following excellent precept on this point.—" Beware," says he, " of sudden change in any great point of diet, and if necessity enforce it, fit the rest to it. For it is a secret both in nature and state, that it is safer to change many things than one.'

Imitation without judgment.

To be continued.

SCIENTIFIC NEWS.

The Society of Goerlitz, in Saxony, has offered a prize of thirty crowns, for the solution of the following Questions.

Prize Questions by the Society of Goerlitz. 1. Freezing. 2. Ancient manners, &c.

1. IN cloudy weather, it will scarcely freeze until the thermometer of Reaumar has descended to the point of Zero, or very little above it: whence does it happen, that when the sky is clear, it freezes while the same thermometer indicates three or four degrees above the point of congelation.

2. It is required to collect and arrange from the works of

of Plautus, every thing which relates to the knowledge of men and things in his time, so as to exhibit an outline of the civilization and manners of that period.

Interior temperature of the Earth.

The question concerning the absolute or relative temperature of the interior parts of the earth, has been long agitated, though it now appears to be decided that our globe contains no internal source of heat, if we except the occasional combustions of volcanoes.

Mr. De Trebra, captain of mines at Freyburg, and Professor Lampadius, have directed some experiments to this object. They placed two thermometers of Reaumur at different depths in the mines, and compared them twice a day with one exposed to the atmosphere. One of the subterraneous thermometers stood constantly at 12° and the other at $9\frac{1}{2}$ Mr. De Trebra, who intends to repeat and vary these experiments, purposes likewise to make some others relative to the theory of Dr. Benzenburgh on the fall of bodies.

Galvanism and Magnetism.

Ritter's Experiments on Magnetism.

Professor Ritter has communicated to the Royal Academy of Sciences, of Munich, in one of its sittings last year a course of experiments, referring directly to the nature of magnetism.

In the years 1776 and 1777, the Academy had already proposed questions on this subject, and the scientific world was busied in considering the relations which might exist between electricity and magnetism.

General facts.

The following are the results of the experiments of Ritter, as abridged by Professor Millin in his Magasin Encyclopedique for May last.

The Magnet acts like two metals

1. Every magnet is equivalent to a pair of heterogenous metals united together; its different poles represent as it were different metals.

—and gives electricity.

2. Like them, it gives electricity; that is to say, one of the two poles, the positive electricity, and the other the negative.

3. By

3. By following the same process, a certain number of magnets, as well as a certain number of pairs of metals, afforded electricity; and in this manner the electricities afforded by the poles of different magnets, have been successfully indicated by the electrometer. Piles of Magnets will affect the Electrometer.

4. By means of these electricities, one of these batteries of magnets, accordingly as it is more or strong, produces upon dead and living bodies, all the phœnomena which are produced by a pile of Volta of the common kind, and of the same force. —and Galvanize bodies.

5. The exper iments which prove this, shew, that in magnetised iron the south pole gives positive electricity, and the north pole negative electricity; but that on the contrary in magnetised steel, the north pole affords the positive electricity, and the south pole the negative. The poles in iron and steel have different electricities,

6. The same inverse disposition is also observed with regard to the polar oxidability of the magnetized body in which this change is produced by magnetism. In magnetized iron the south pole is most oxidable, and the north pole least; whereas in magnetized steel the north pole is most oxidable and that of the South least. —and contrary oxidabilities.

7. Mr. Ritter thinks, that by considering the earth as an immense magnet, these results might serve to explain various phœnomena of nature, such as physical difference between the two hemispheres, the Aurora-borealis, and the Aurora Australis. In fact, after what has been just stated, the earth considered as a magnet, may be taken as an equivalent to an immense pile of Volta of which the poles are on one side sufficiently closed by the waters of the ocean. And the action of this pile must produce, and have produced the greatest chemical changes in the materials of the earth; changes which must have differed according to the poles; and of which pile the poles at the other extremity have always such an abundance of electricity as to cause its splendor to appear by radiations in the vast spaces of the heavens. The Earth an immense magnet, producing electric effects, &c.

National

National Industry.

Prizes.

Prizes offered by the Society for encouragement of National Industry, in France, at its general sitting of Jan. 29 last.

—for sizing Paper.

1. For sizing of paper, a prize of three thousand francs, is offered to him who shall indicate a less expensive and more perfect process than is at present employed in the paper manufactories of France.

—Vermillion.

2. For the fabrication of cinnabar, equal to that called Chinese vermillion, a prize of twelve hundred francs.

—Block Engraving.

3. For the encouragement of engraving in relief, or producing blocks for printing, two thousand francs.

The Society invites the concurrents, to discover mechanical or chemical means of facilitating the processes of this method of engraving, without losing sight of the requisite degree of perfection. They also direct the attention of artists towards the most useful objects, such as designs of machines, and apparatus of every kind, architecture, and nautral history, in its various branches, and ornaments for letter press, &c.

The preceding prizes will be decreed in the year 1807, the following are for the year 1808.

Brick and Tile Furnaces.

1. For the best construction of furnaces for lime, tiles, and bricks, a prize of 2400 francs, and two other prizes of 500; to those who shall have approached the nearest in succession to the object of this program, of 300 francs.

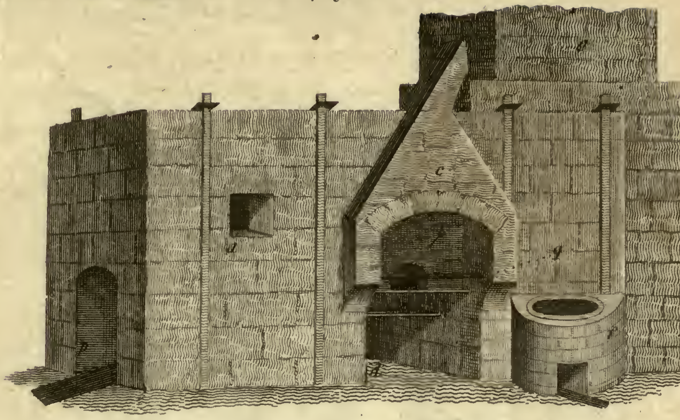
The society take notice, and their remark is probably applicable to the processes made use of in this country, that great savings of fuel, and other advantages have been derived from scientific improvements in the furnaces made use of in many of the arts; but that in the fabrications which form the subject of the present question, no such improvement has taken place; they therefore offer the before mentioned prizes to those who shall establish works in France in which these articles shall be made with the least expence of fuel

Horse-beans.

2. For the culture of horse beans, on a large scale, in a district where they are not at present used, 600 francs.

Jones, Printer, Chapel-street, Soho.

Nicholsons Philos. Journal Vol. 15. Pl. 1. page 80



Smelting of Lead

Fig 2nd

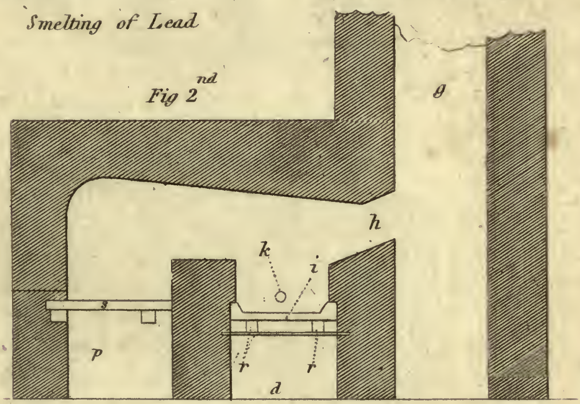
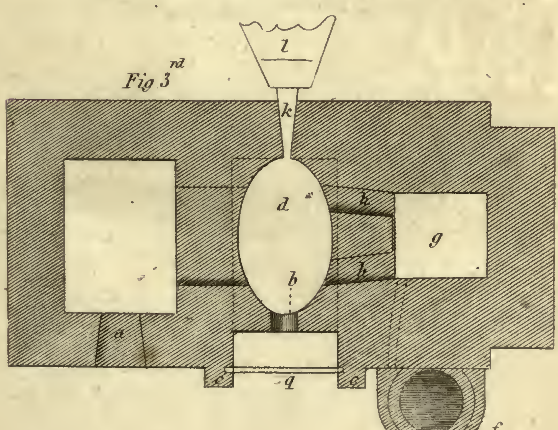


Fig 3rd



Smelting of Lead

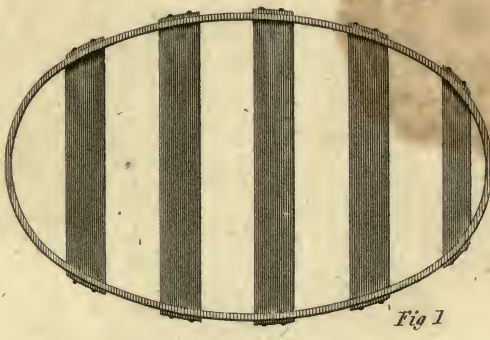


Fig 1

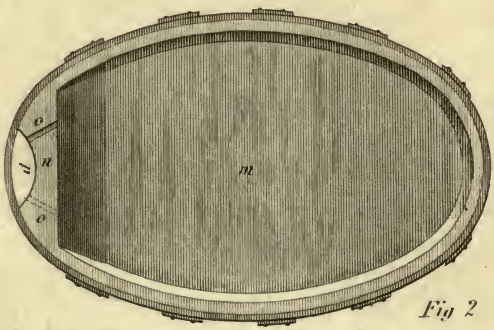


Fig 2

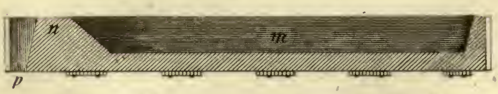


Fig 3

A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND

THE ARTS.

OCTOBER, 1806.

ARTICLE I.

Letter from Richard Lovell Edgworth, Esq. *containing a Description of an Odometer for a Carriage, and some Remarks on the Patent Boring Machine of Mr.* Ryan.

To Mr. NICHOLSON.

Edgeworthstown, Ireland, Aug. 29, 1806.

Sir,

I SEND you a drawing of an Odometer for a carriage, which I request you will insert in your Journal when it is entirely convenient to you.

Description of an Odometer, or instrument for measuring the ground passed over by a carriage.

This Odometer is more simple than any which I have seen, is less liable to be out of order, and may be easily attached to the axletree bed of a postchaise, gig, or any other carriage.

One turn and a half of a screw is formed round the nave of one of the hinder wheels by a slip of iron three quarters of an inch broad and one-eighth of an inch thick; this is wound round the nave, and fastened to it by screws passing through five or six cocks, which are turned up at right angles on the slip of iron. The helix so formed on the nave of the carriage wheel acts as a worm or screw upon the teeth of the wheel A, upon the

Description of an Odometer, or instrument for measuring the ground passed over by a carriage.

arbor of which another screw of brass B is formed, which acts upon the brass wheel C. (Fig. 1, Pl. III.) This wheel C serves also as a dial-plate, and is divided into miles, halves, quarters, and furlongs; the figures indicating the miles are nearly three quarters of an inch long, so as to be quite distinct; they are pointed out by the index D, which is placed as represented in the plate, in such a manner as to be easily seen from the carriage.

These two brass wheels are mounted by the irons E E upon a block of wood F, eight inches long, two inches thick; and five inches broad. This block may be screwed upon the axletree-bed by two strong square-headed wood-screws. If the carriage permits, this block should be fixed obliquely on the axletree-bed, so that the dial-plate may be raised up toward the eye of the person looking out from the carriage.

H is a ratchet wheel attached to the arbor of the wheel A, which, by means of the click I, allows the wheel to be set with a key or handle fitted to the squared end of the arbor at K. L is a long spring screwed on the block; it presses on the wheel A, to prevent it from shaking by the motion of the carriage. A small triangular spring is put under the middle of the dial-plate wheel for the same purpose.

If the wheel of the carriage is exactly five feet three inches in circumference, the brass toothed wheel which it turns should have twenty teeth, and that which serves as a dial-plate should have eighty; it will then count five miles. If the carriage wheel is either larger or smaller, a mile should be carefully measured on a smooth road, and the number of turns which the carriage wheel makes in going this mile may easily be counted by tying a piece of fine packthread to one of the spokes and letting the wheel, as it moves slowly forward, wind up the packthread on its nave. When the wheel has proceeded a half or a quarter of a mile, unwind the string and count the number of turns which it has made.

By the addition of another wheel of eighty-one teeth placed under the dial-plate wheel and moved by the screw C, with a proper hand fitted to it, and proper figures on the dial-plate, this machine would count four hundred miles.

Boring Machine.

I take this opportunity of mentioning a trial that I lately made of Mr. Ryan's patent Boring Machine, for exploring the strata of mineral countries. This machine acts like the surgical *trepan*, and cuts a circular hole, leaving a *core* in the middle which is drawn up from time to time by a pair of self-closing tongs.

Boring machine of Mr. Ryan. It cuts out a circular piece, acting like the trepan.

I found that this gentleman's machine, from his want of knowledge how to push his own invention, had not obtained due credit; I therefore invited him to try his machine at my house, that I might witness the result of the experiment.

Two men, relieved from time to time, cut a truly circular hole, five inches and a quarter in diameter, through a block of hard limestone, leaving a *core* a little taper of four inches and a half diameter and six and three quarters in length, which core is now in my possession. It is as true and as smooth as if turned and polished in a lathe, and the under surface shews exactly the fracture by which it was detached from the block at bottom.

Five inch hole cut through lime stone.

By this contrivance mines may be ventilated at small expense, the specimens of strata that are bored through may be brought up whole and unmixed, no deception can take place; and not only the dip, but the fracture, lap, and accidents to which each stratum is liable, may be determined at any depth. True vertical and horizontal sections may be previously obtained of any spot where it is proposed to sink shafts; and the subterraneous topography of a whole district may be laid down upon a map with confidence before any great expense is hazarded on mere speculation.

The pieces being brought up entire afford a very accurate knowledge of the strata,

I am, Sir,
With regard and esteem,
Your faithful humble servant,

RICH. LOVELL EDGEWORTH.

II.

Remarks on a Paper of Mr. Boswell *on invariable Pendulums, &c. In a Letter from* J. G.

To Mr. Nicholson.

Sir,

Introduction to Remarks on a Paper of Mr. Boswell.

As you do not appear to be averse to the insertion of any critical observations upon such papers of your Journal as may happen to contain any defective inferences, I am induced to transmit you the following remarks on a paper of Mr. Boswell's, relative to pendulums, published in your Number for February 1805, which I have but just seen.

Mr. B. considers the *magnitude* of bodies submitted to pyrometrical experiments as an element of great importance,

Mr. Boswell commences his paper by observing that the magnitude of the bodies submitted to pyrométrical experiments has been very generally neglected, a point which he would insinuate to be of material importance in all considerations of this nature. He then proceeds to state the obvious circumstance that bodies are more or less speedily affected by the temperature of any surrounding medium, according to the proportional number of their particles which are in contact with this medium; a circumstance which, as he observes, is dependent on the shape and mass of the given body. From hence he deduces the following inferences:

— whence he infers that a large body would be little changed by the atmosphere.

"1. That the greater the bulk of any body, the less "will be its mutability of temperature in proportion, "and, of course, the less will it alter its degree of ex"pansion."

"2. That a large globe, in the first place, or a cylin"der whose height was equal to its diameter, in the next "place, or, in the third place, a large cube, would have "its dimensions very little changed by the fluctuations "of atmospherical temperature."

But Mr. B. does not attend to partial expansion.

The above inferences appear to be inadmissible from a circumstance which Mr. Boswell seems to have overlooked, viz. the possibility of a partial expansion of the given body, or of the expansion of one part independently of the remainder, Mr. Boswell's inferences requiring no expansion to take place until each particle has assumed the temperature of the surrounding medium.

It

It is well known that a bar of iron may be heated red hot at one extremity without effecting any sensible change in the temperature of the other extremity: would Mr. Boswell thence infer that no expansion whatever has taken place in the bar? will he not rather admit a certain expansion to have been produced in the heated end, and a gradual decrease of this expansion to have extended toward the cold extremity?

A bar of iron may be red hot at one end and cold at the other;

— and would expand where heated.

If the preceding effect be admitted to take place in a bar of metal, it must equally be admitted in every body which is susceptible of expansion by heat: Mr. Boswell's contrivance for rendering effective the compensations proposed by Crosthwaite or Pine must consequently be nugatory, were the apparatus affixed even to the side of a mountain of granite in lieu of his octagonal pillar. The other suggestions of Mr. Boswell, in which deal, mahogany, or metal is employed, I should apprehend to be still less deserving of attention; and I am incapable of perceiving the good effect which is likely to arise from the filling the glass tube with semen lycopodii or sawdust, or from the covering it with oiled silk.

And so would Mr. Boswell's large body.

Objection to some other of his contrivances.

In his observations on a paper published in the Repertory of Arts, relative to Pine's and Crosthwaite's pendulums, (which, by the bye, appear to me equally harsh and unjust,) Mr. Boswell triumphs in his turn, with no small satisfaction, on a supposed error of the author; a triumph which the preceding remarks will not so readily authorize; it may be even doubted whether the effect would not have been greater in the *solid plank* than in the simple rod. The cock through which the pendulum spring passed in order to effect the proposed compensation, I imagine to have been affixed to the plank by screws: now, if from the imperfect conducting power of wood, with respect to caloric, we suppose the exterior strata to expand from an increase of temperature, and that the expansion of the interior strata gradually decrease, as in the afore-mentioned bar of iron, it is evident that the screws will turn, as it were, on their interior extremity, and form an angle with the axis of the plank, supposing them to have been perpendicular to the axis before the expansion took place; consequently the outer

Mr. B.'s animadversions on Mr. Pine's paper, not founded on facts.

Explanation.

A thick plank of support may be less effectual than a thinner.

outer extremity of the cock would be farther removed from any fixed point in the axis of the pendulum than if the expansion had been uniform throughout, in which case the screws would have maintained their perpendicularity. The same reasoning will not apply to the simple rod, the expansion being equal in all the concentric strata.

Gridiron pendulums are adjusted while actually going.

Mr. Boswell's errors with regard to the pyrometer have been so ably noticed by you, that it would be absurd in me to touch upon them; but his objections to the gridiron pendulum, on account of the mixed metals of which it is composed, do not appear to have been controverted: Mr. Boswell ought, however, to have been aware that an adequate allowance for adjustment is constantly made in their construction, to obviate any defects which may arise from a faulty estimation of the comparative expansions of the different parts of the instrument, as described in the account of the excellent seconds pendulum of your own construction.

I am, Sir,

Your obedient servant,

J. G.

III.

A Third Series of Experiments on an artificial Substance which possesses the principal characteristic Properties of Tannin; with some Remarks on Coal. By Charles Hatchett, Esq. F.R.S.*

(Concluded from page 31.)

VII.

Experiments, &c. on an artificial substance having the characters of tanning matter.

After the tanning substance and the other products had been obtained from the resins, balsams, &c. which have been mentioned in the beginning of this Paper, the following proportions of coal remained †:

* Philos. Trans. 1806. For the former Papers see our Journal.

† The weight of the coal obtained from each of the abovementioned substances, was estimated after the complete separation of every other product, and after the moisture had been expelled by a red heat, in close vessels.

100 grains

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		Coal.
100 grains of	Copal	67 grains.
———	Mastich	66
———	Balsam of Peru	64
———	Elemi	63
———	Tacamahac	62
———	Guaiacum	58
———	Gum ammoniac	58
———	Amber	56
———	Olive oil	55
———	Balsam of Tolu	54
———	Asa fœtida	51
———	Wax	50
———	Dragon's blood	48
———	Benzoin	48
———	Olibanum	44
———	Myrrh	40
———	Asphaltum	40
———	Gamboge	31
———	Elastic bitumen	31
———	Gum arabic	29
———	Liquorice	25
———	Manna	25
———	Tragacanth	22
———	Caoutchouc	12*

The coal obtained from the resinous bodies by means of sulphuric acid, is in a much greater proportion, than when equal quantities of those substances are exposed to simple distillation.

For, (as I have stated in my first Paper,) 100 grains of common resin by the humid process afforded 43 of coal; which after a red heat still weighed 30 grains.

But the same quantity of resin by distillation, only yielded ¾ of a grain of coal.

One hundred grains of mastich, by the first method, afforded 66 grains of coal.

* Caoutchouc and elastic bitumen were only superficially carbonized by the sulphuric acid, so that the proportion of coal as above stated, is considerably less than that, which in reality might have been obtained from them.

 One

Experiments, &c. on an artificial substance having the characters of tanning matter.

One hundred grains of the same mastich only gave $4\frac{1}{2}$ grains of coal when simply distilled.

And 100 grains of amber, when treated with sulphuric acid, yielded 56 grains of coal.

But from 100 grains of the same amber when distilled, only $3\frac{1}{2}$ grains could be obtained.

Many other examples might be adduced, but these appear to be sufficient; and I must here observe, that the case is very different in respect to the gums, for the difference between the proportions of coal obtained from them by the humid and dry ways is not very considerable, although it is always the greatest in the former process, when conducted with precaution. Moreover it is to be remarked, that in either process, variations in the quantity of coal are produced by difference of temperature, by the figure and size of the vessels, and many other circumstances.

But it is not only in the proportion, that there is so great a difference between the coal obtained from the resinous substances by the humid way or by fire, for the quality is also most commonly different; and this not only applies to the resins but also to ligneous matter.

The coal obtained by the humid process from many of the resins, was shining, hard, and occasionally iridescent. Few of the coals obtained from the same bodies by fire had any of these properties. The combustion of the former was slow in the manner of some of the mineral coals, whilst on the contrary the latter were speedily consumed like charcoal. This difference I was at first inclined to attribute to a small portion of the acid which might not have been completely separated, and I therefore purposely made some experiments which convinced me that this was not the case.

Having remarked this difference in the coals afforded by the resins, I was desirous to make some comparative experiments on wood, and for this purpose I selected oak.

I.

On 480 grains of oak sawdust I poured two ounces of sulphuric acid diluted with six ounces of water, and placed the matrass on a sand-bath, where it remained from

from the beginning of last June to the end of September. During this time, the sand-bath had very seldom been heated, but the vessel was occasionally shaken.

Experiments, &c. on an artificial substance having the characters of tanning matter.

At the end of the period above mentioned, six ounces of boiling water were added, and the whole being poured upon a filter, was repeatedly washed, and was afterwards dried on a sand-bath in a heat not much exceeding 300°.

The sawdust appeared to be reduced to a granulated coal, partly pulverulent, and partly clotted; the whole weighed 210 grains.

One hundred and five grains of this coal were put into a platina crucible, and were exposed to a red heat under a muffle. At the same time, an equal quantity of charcoal made from the same oak sawdust, was placed in another vessel by the side of the former.

The charcoal was speedily consumed, and left some brownish-white ashes, which as usual, afforded alkali, with a trace of a sulphate, which was probably sulphate of potash.

On the contrary, the coal formed by the humid way, burned without flame, similar to the Kilkenny coal, and others which do not contain bitumen. It was very slowly consumed, like the mineral coals above mentioned, and left some pale red ashes, which weighed 2 grains. These ashes *did not yield* the smallest vestige of *alkali*, and the only saline substance which could be obtained, was a very small portion of sulphate of potash, which did not amount to more than one-fifth of a grain; and it is probable, that had the coal been more copiously washed, even this small portion of the neutral salt would not have been obtained.

2.

At the time when the preceding experiment was began, I also put 480 grains of the oak sawdust into another matrass, and having added four ounces of common muriatic acid, the whole was suffered to remain during the period which has been mentioned.

At the end of the four months, the remainder of the acid was for the greater part driven off by heat not exceeding 300°. The sawdust then had the appearance of a brownish-black mass, on which about a pint of boiling

 distilled

Experiments, &c. on an artificial substance having the characters of tanning matter.

distilled water was poured; the whole was decanted into a filter, was repeatedly washed, and was afterwards dried without heat. The sawdust then appeared, as I have observed, brownish-black, and was pulverulent. It burned with some flame, emitted still a slight vegetable odour, and was reduced to ashes much sooner than the coal formed by sulphuric acid, but not so speedily as the oak charcoal. The ashes had an ochraceous appearance, and were almost devoid of any saline substance, excepting a very slight trace of muriate of potash.

These two experiments therefore prove,

1st. That wood may by sulphuric acid be converted into a coal which in its properties is very different from charcoal, although prepared from the same sort of wood; and that the coal thus formed by the action of sulphuric acid, resembles by its mode of burning, and by not affording any alkali when reduced to ashes, those mineral coals which are devoid of bitumen.

2dly. That wood may also be converted into a sort of coal by muriatic acid, but in this case some of the vegetable characters remain, although, like the former, not any alkali can be obtained from the ashes.

§VIII.

Four different solutions have been proposed respecting that difficult problem in the natural history of minerals, *the origin and formation of coal.*

The first is, that pit-coal is an earth or stone chiefly of the argillaceous genus, penetrated and impregnated with bitumen.

But Mr. Kirwan very justly remarks, that the insufficiency of this solution is demonstrated by Kilkenny and other coals which are devoid of bitumen, and also that the quantity of earthy or stony matter in the most bituminous coals bears no proportion to the weight of them*.

The second and most prevailing opinion is, that mineral coal is of vegetable origin, that the vegetable bodies have, subsequent to their being buried under vast strata of earth, been mineralized by some unknown process, of

* Geological Essays, p. 316.

which,

which, sulphuric acid has probably been the principal agent, and that by means of this acid, the oils of the different species of wood have been converted into bitumen, and a coaly substance has been formed.

Experiments, &c. on an artificial substance having the characters of tanning matter.

The third opinion is that of ARDUINO; who conceives coal to be entirely of marine formation, and to have originated from the fat and unctious matter of the numerous tribes of animals that inhabit the ocean.

And the fourth is Mr. KIRWAN's opinion, who considers coal and bitumen to have been derived from the primordial chaotic fluid*.

The limits of this Paper will not permit me to enter into the various arguments and facts which have been adduced in the support of these different opinions; but the second, or that which regards the vegetable substances as the principal origin of coal, seems by much the most probable, because it is corroborated by the greater number of geological facts, as well as by many experimental results. Most of the former have however been stated in different works, and I shall therefore only notice a few of the latter which have occurred in the course of my experiments.

The observations of Dr. CORREA DE SERRA on the wood of the submarine forest at Sutton, on the coast of Lincolnshire, together with similar accounts which have been published in the Philosophical Transactions and other works, demonstrate in the most satisfactory manner, that whether vegetables are totally or partially buried under the waves or under the earth, they are not merely by such means converted even into the most imperfect sort of coal†. Some process therefore independent

* Geological Essays, p. 327.

† In my Paper, "*On the Change of some of the proximate Principles of Vegetables into Bitumen*," I have quoted the remarks of BERGMAN, VON TROIL, and others, on the compressed state of the trunks of the trees which have been converted into surturbrand, Bovey coal, and similar substances. The same observation has been also made by Dr. CORREA DE SERRA respecting the timber of the submarine forest at Sutton; and this is the more remarkable, as the submerged vegetables at Sutton do not exhibit any appearance of carbonization.

Experiments, &c. on an artificial substance having the characters of tanning matter.

ent of these circumstances must have taken place, in order that the vegetable substances, such as ligneous matter, resin, oil, &c. should become coal and bitumen.

In a former Paper I have endeavoured to shew, that these changes are progressive, and having noticed the perfect state of the submerged wood at Sutton and other places, I next described the qualities of the different kinds of Bovey coal, which exhibit a series of gradual changes from bodies which retain the vegetable structure and texture, although imperfectly carbonized, to others in which almost the complete characters of the common mineral or pit-coal are absolutely established.

From the alder leaves in the schistus from Iceland, I obtained extractive vegetable matter, and although this was not afforded by the varieties of Bovey coal, yet these, as well as the alder leaves, and also a coal like that of Bovey, found in Sussex, at Newick Park, (an estate belonging to Sir ELIJAH IMPEY,) and also the surturbrand of Iceland, yielded some resin, which at Bovey is likewise found in distinct masses, intermixed with the strata of coal, and combined with asphaltum, in the proportion of about 41 parts of the latter with 55 of resin *.

Now, exclusive of the other vegetable characters which are so evident in many of the varieties of Bovey coal, of the Sussex coal, of surturbrand, &c. &c. the presence of resin must be regarded as a strong fact: for this substance has always been attributed to the organized bodies, particularly to those of the vegetable kingdom, and I do not know of any instance, previous to my own experiments, in which, resin had been discovered as constituting part of any of the different species and varieties of coal.

From the external vegetable characters possessed by the

Dr. CORREA says, "In general the trunks, branches, and roots of "the decayed trees, were *considerably flattened;* which is a pheno- "menon observed in the surturbrand or fossil wood of Iceland, "and which SCHEUCHZER remarked also in the fossil wood found "in the neighbourhood of the lake of Thun, in Switzerland." Phil. Trans. 1799, p. 147.

* Observations on the Change of some of the proximate Principles of Vegetables into Bitumen, Phil. Trans. 1804, p. 405.

the Bovey coal, the Sussex coal, the surturbrand, and many others, together with the resin, (allowed to be exclusively a vegetable substance, or at least one which only appertains to the organized natural bodies,) there cannot be any doubt, that such coals have been formed from wood and other substances belonging to the vegetable kingdom.

Experiments, &c. on an artificial substance having the characters of tanning matter.

But some mineralogists attempt to draw a line of separation between the coals above mentioned and the others, which therefore they call the true mineral coals.

This opinion may in some degree be refuted even from the specimens afforded by the Bovey coal-pits, where, as I have observed, a regular gradation may be seen from wood which is but very imperfectly carbonized, to the substance called stone coal, which in every respect appears to be most nearly if not absolutely similar to the common pit-coals*.

It may however be objected, that such a transition is peculiar to this and similar places, and that the pit-coal found in other situations, where nothing resembling the Bovey coal can be discovered, is in reality of a different nature.

But this objection I think may be answered by the results of those experiments on pit-coal, Cannel coal, and asphaltum, which I have related in the third section of this Paper; for when these were subjected to the action of nitric acid not too long continued, it was found, that the acid first dissolved the principal part of the carbonaceous matter, and if then the process was stopped, there remained a substance in a proportion corresponding to that of the bitumen either in the pit-coal, or principally forming the Cannel coal and asphaltum, which although not absolutely in the state of resin, was however in a state intermediate between it and the vegetable extractive matter.

Moreover I have stated, that under similar circumstances, a substance possessing in a great measure the same properties, may be obtained from the known vegetable resins by the action of nitric acid.

* Phil. Trans. 1804, p. 398.

When

Experiments, &c. on an artificial substance having the characters of tanning matter.

When therefore, these facts are added to that of the natural mixture of resin and asphaltum which is found with the Bovey coal, we to all appearance have almost positive proof that the pit-coals are of vegetable origin.

True it is indeed, that bitumen has never been formed by any artificial process hitherto devised, from the resins or other vegetable substances. I have myself attempted it in various ways without success, for although I occasionally obtained products which resembled it somewhat in odour when burned, and other properties, yet the effects of alcohol or water always proved these products not to be bitumen.

But synthesis of natural products, although required in strict chemical demonstration, is (as we have but too often occasion to know) seldom to be attained, especially when operations are performed on bodies whose component parts are liable to an infinite series of variations in their proportions, qualities, and mode of combination.

Considering therefore, that bitumen and resin afford by certain operations similar products, that resin and bitumen are found blended together by nature, and that this mixed substance accompanies a species of coal which in many parts still exhibits its vegetable origin, whilst in others it passes into pit-coal, we may with the greatest probability conclude, that bitumen is a modification of the resinous and oily parts of vegetables, produced by some process of nature, which has operated by slow and gradual means on immense masses, so that even if we were acquainted with the process, we should scarcely be able to imitate its effects, from the want of time, and deficiency in the bulk of materials.

But although bitumen cannot at present be artificially formed from the resinous and other vegetable substances by any of the known chemical processes, yet there is every reason to believe, that the agent employed by nature in the formation of coal and bitumen has been either muriatic or sulphuric acid; and when it is considered, that common salt is never found in coal mines except when in the vicinity of salt springs, whilst on the contrary, pyrites, sulphate of iron, and alum, most commonly

monly are present*; these facts, together with the sulphureous odour emitted by most of the mineral coals when burned, appear strongly to evince the agency of the latter. That this has been the case, seems also to be corroborated, by the great resemblance which (as has been previously stated) the coals formed artificially from many vegetable substances bear to the mineral coals, especially as the similarity is not confined to external characters, but extends to other properties.

Experiments, &c. on an artificial substance having the characters of tanning matter.

By the action of sulphuric acid on vegetable bodies, a much greater portion of their carbon is converted into coal than when the same are subjected to the effects of fire. Several examples respecting the resins, have been mentioned in the seventh section of this Paper, and the result of the experiment made upon oak perfectly accords with them.

Mr. Proust, in the course of some comparative experiments on the proportions of charcoal afforded by different kinds of wood, obtained 20 *per cent.* from green oak, and 19 *per cent.* from heart of oak †.

But by sulphuric acid, from 480 grains of oak, I obtained 210 grains, or about 45 *per cent.* of coal, which burned not like the charcoal obtained from the same wood, but like many of the mineral coals; and this was also observed in the combustion of the greater part of the coals obtained by the humid way from resinous substances.

The experiment on oak also appears to refute another objection to the vegetable origin of pit-coal, namely, the total absence of the alkalis, which on the contrary are so constantly obtained from the ligneous parts of vegetables by combustion ‡. But I have shewn, that when these bodies are carbonized in the humid way either by muriatic or by sulphuric acid, not any alkali can be obtained from the ashes of coals so formed; and this seems also to be a farther proof, that the humid way has been employed in the operations of nature to convert the above mention-

* Kirwan's Geological Essays, p. 324.

† *Journal de Physique*, 1799, Tome 48, p. 469.

‡ Kirwan's Geological Essays, p. 320.

ed

Experiments, &c. on an artificial substance having the characters of tanning matter.

ed substances into pit-coal; for supposing fire to have been the agent, it does not appear easy to conceive how the alkali could have been destroyed or separated*.

Every circumstance seems therefore to support the opinion of those who consider the pit-coals as having been formed in the humid way, principally from vegetable bodies, and most probably by the agency of sulphuric acid; and allowing that animal substances may also have contributed to the production of coal, yet this would not militate against the above mentioned opinion, as the effects produced upon them by that acid would in all the essential points be perfectly similar†.

An

* Some have attempted to account for the absence of alkali in the Bovey coal and common pit-coal, by supposing that the vegetable bodies (from which these have been formed) were previously deprived of alkali by simple lixiviation during their immersion in water. But in page 127 of this Paper, I have shewn that the submerged oak of Sutton, although deprived of its tannin, still retained its potash, which certainly would not have been the case if the latter like the former could have been separated from the wood by mere solution. When wood is reduced to ashes, the alkali becomes completely denuded by the destruction of the woody fibre, and consequently may be immediately taken up by water; but when wood is converted into coal in the humid way by means of an acid, then it seems to me that two effects take place; for the intimate combination of the alkali with the woody fibre becomes in a great measure destroyed by the carbonization of the latter, whilst a simultaneous action arises in the affinity between the acid and the alkali; so that if coal has been formed by such means, the alkali must have been separated from the wood, in the state of a dissolved neutral salt.

† From the nature of the experiments which have been related in this Paper, I have unavoidably been induced to notice concisely the different opinions on the formation of coal by the humid way; but I did not intend to have mentioned any of those which have been brought forward in favour of the immediate or indirect action of fire, as I only wished to express my sentiments respecting the most probable of the former opinions.

Since however this Paper was written and partly read before the Royal Society, I have been favoured by Sir JAMES HALL, with a copy of his Paper, intitled "*Account of a Series of Experiments, shewing* "*the Effects of Compression in modifying the Action of Heat*;" and I am fully of opinion that the scientific world has not for a long time received any communication of more importance, or in which more accuracy, ability, and perseverence have been displayed. The effects which Sir JAMES HALL has produced on carbonate of lime, by heat acting under compression, certainly removes a great and at

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An inquiry into the nature and formation of coal was my first object when I discovered the artificial tanning substance, and considering the importance of the latter, it will not appear surprising, that it should immediately have engaged the principal part of my attention.

Experiments, &c. on an artificial substance having the characters of tanning matter.

In addition to the experiments which have been related in the three Papers upon this subject, I intended to have decomposed the different varieties, to have compared their gases and other products with those of the natural substance, called Tannin, and especially to have endeavoured to discover more economical methods of obtaining the artificial product; for, exclusive of speculative science, this appears to be an object of consequence, not only respecting that useful and valuable branch of manufacture, to which it immediately relates, but also as the means of preventing, or at least of diminishing, the premature destruction of timber in a country, where, on account of its population, as well as on account of its maritime position, every economy in such an article should be most rigidly observed.

But for the present, I intend to relinquish this subject to such as may consider it worthy of attention; whilst,

one time apparently insurmountable obstacle to the HUTTONIAN or PLUTONIAN theory, and if they do not solve the grand geological problem, they must even, in an insulated point of view, be allowed to have opened a new and unexplored field of research in chemistry as well as in geology.

In the 8th section of this valuable Paper, the author has given an account of some experiments made on leather, horn, and fir sawdust, from which he obtained coal which burned with flame, and which apparently resembled some of the mineral coals. In one case also, he obtained a substance, which in external characters appeared somewhat similar to the mixture of asphaltum and resin found at Bovey, to which I have given the name of Retin-asphaltum. These experiments Sir JAMES HALL intends to resume, and it is my earnest wish that he would do so; for although I am strongly inclined to believe that the mineral coals have generally, if not always, been formed by some humid process, yet it is impossible to foresee the results which may be obtained from animal and vegetable bodies subjected to the effects of heat modified by compression, as the principles of these bodies may be acted upon, and may be made to react on each other, under circumstances which until now have not been imagined.

 as

Experiments, &c. on an artificial substance having the characters of tanning matter.

as I have already stated, I entertain very sanguine expectations, that eventually it will prove economically useful; and should any be inclined to pursue the inquiry, I would recommend particular attention to those processes which relate to the roasted vegetable substances, and to peat.

Almost any refuse vegetable matter, such as twigs, dead leaves, &c. will serve for the former; whilst the latter, as I have shewn, does not require to be roasted, and in many, especially the northern counties, peat is found in such abundance, that but a small proportional quantity is consumed in the only useful way to which it has hitherto been applied, namely, fuel.

Before I conclude this Paper, I shall also observe, that the experiments which have been described, must be regarded only as a mere sketch of that which may be performed, whilst the facts which have been ascertained respecting the resins, balsams, gum resins, and gums, serve to prove, that much may be expected from regular chemical examinations of these bodies. But such investigations, in order that science may truly be promoted, should be strictly regular: that is, they should not be taken up in a desultory manner, but these substances should be comparatively and systematically examined with all the accuracy which can be employed in the present state of chemical knowledge; for as this knowledge concerning the composition of organized bodies is confessedly very imperfect, I am persuaded, that like other of the sciences, chemistry will be less liable to error, when guided by comparative experiments and comparative analysis.

III.

Discussions relating to the Claims of Lavoisier as an Inventor of Chemical Theory. In a Letter from JONATHAN STOKES, *M. D.*

Chesterfield, Aug. 31, 1806.

To MR. NICHOLSON.

SIR,

It is strange that Lavoisier in his last me-

I HAVE perused with much satisfaction your remarks and those of your correspondent E. D. on the subject

ject of Lavoisier's claim to the establishment of the present theory of what may be called aërial chemistry. I have ever regarded him as its author, but the mode in which he has asserted his rights appears so reprehensible, that nothing but my entire conviction of the integrity of his amiable relict could induce me to believe that the fifth memoir translated in your Journal for Jan. p. 81, contains the whole of what he wrote on that subject. Had the editor been unknown to me, I should have said—is it possible that Lavoisier who did so much justice to the discoveries of his predecessors in his Opuscules, could have entered so minutely into the Theories of Rey, Lomery, Charras, Stahl and Morveau, and yet omit to notice the experiments of Hales and Priestley? why has the editor omitted to print the following passages which he must surely have found in the author's hand-writing? "Tous "les physiciens de son temps pensoient que le feu se fixoit se "combinoit avec les metaux, et que c'étoit cette addition "qui les reduissoit a l'état de chaux. M. Hales ne "s'est point écarté de cette opinion; mais il a de plus "avancé que l'air contribuoit a cet effet, et que c'étoit "en partie a lui qu'étoit du l'augmentation de poids des "chaux métalliques. Il fondoit cette opinion sur ce "qu'ayant soumis 1922 grains de plomb à la distillation, "il n'en avoit retiré que 7 pouces d'air, tandis qu'une "égale quantité de minium lui en avoit fourni 34. M. "Hales a encore remarqué que le phosphore ou plutôt "le pirophore de Homberg diminuoit le volume de l'air "dans lequel on le brûloit;—que les végetaux en fer- "mentation produisoient d'abord une grande quantité "d'air qu'ils absorboient ensuite. Quant a la com- "bustion du volume de l'air qui s'opere pendant la com- "bustion de quelques corps, tantôt il l'attribue a la perte "de son elásticité, tantôt il semble croire que cet air est "réellement fixé et absorbé pendant la combustion. M. "Hales termine son sixième chapitre, en concluant que "l'air d'atmosphère, entre dans la composition de la plus "grande partie des corps, qu'il y existe sous forme solide, "depouillé de son elásticité et de la plus grande partie "des proprietés que nous lui connoissons, que cet air est, "en quelque façon le lien universel de la nature, qu'il

moir has neglected the rights of other chemists.

He did not formerly overlook them.

He mentions Hales in his opuscules.

Who ascribing the increase of M. calls it air.

—and considered it in combustion.

—and taught that it may be fixed, &c.

"est le ciment des corps, que c'est à lui qu'est dû la "grande dureté de quelques-uns, une grande partie de "la pessanteur des autres ; que cette substance est com- "posée des parties si durables, que la violence du feu "n'est point capable des les altérer, et que même après "avoir existé pendant des siècles sous forme solide : elle "peut, redevenir un fluide élastique rare, tout sem- "blable a celui de notre atmosphere.*

Statement of Priestley's discoveries, by Lavoisier.

"M. Priestley a reculé beaucoup plus loin que M. de "Smith, les bornes des nos connoissances ; et on lui est "redevable de quelques faits qui semblent decouvrir un "nouvel ordre decouvrir de choses†. Il suspendit des "morceaux de plomb et d'etain dans des volumes donnés "d'air, et fit tomber dessus, le foyer d'un verre ardent. "L'air se trouva diminué d'un quart : la portion qui "restoit ne fermentoit plus avec l'air nitreux, elle étoit "pernicieuse aux animaux, et elle n'étoit plus suscepti- "ble de diminuer par un mélange de soufre et de limaille "de fer‡. M. Priestley a essayé de calciner les métaux "dans l'air inflammable, dans l'air fixe, et dans l'air ni- "treux, sans pouvoir y parvenir; mais il a observé qu'ils "pouvoient encore se calciner dans un air où le char- "bon ne brûloit plus. M. Priestley explique tous ces "phénomènes par l'émanation du phlogistique ; cette "substance qui se dégage du charbon qui brûle et des "metaux qui se calcinent, se combine, suivant lui, avec "l'air et diminue le volume||. Ces éxperiences de M. "Priestley ont été publiées a la fin de l'année 1772 ; il "y avoit déjà du temps que je m'occupois du même objet "et j'avois annoncé dans un dèpôt fait a l'àcadémie des "sciences le premier Nov. 1772, qu'il se degégeoit une "énorme quantité d'air des reductions metalliques.§"

These passages are inserted in Lavoisier's last memoir.

Had these passages found a place in the memoir, and had we also met with a similar history of Priestley's discovery of dephlogisticated air, and his observations on respiration, we might have become the earnest partisans of an injured philosopher, and exclaimed "this theory is "not, as we often hear it called, the theory of the French "Chemists¶—it is the theory of Lavoisier. Others

* Lavoisier Opuscules, 25. † 87. ‡ 142. || 143. § 109.
¶ Nicholsons's Journal xiii. 85.

"have

" have contributed to its perfection, but the present " theory of oxydation, combustion, and acidification is " Lavoisier's."

Priestley did not theorize but adhered to phlogiston.

Priestley made the greatest discoveries, but not having previously studied chemistry, he in this instance surrendered his understanding to the guidance of an established sect, and admitted the phlogiston of the Stahlians as an elementary principle of bodies; and he was more readily led to continue a follower of the prevailing system of chemistry from having detected an error in the absorbent theory of Hales*.

Lavoisier saw the better part of Hales's theory.

Lavoisier adopted the better part of Hales's doctrine and though he did not at first reject the phlogistic system, he early suspected that charcoal performed other offices in the reduction of metallic calces, besides that of restoring phlogiston to the metallic calx. Whether he or M. Bayen ventured first to deny the existence of phlogiston I cannot ascertain, but previous to the 7th Dec. 1773, Lavoisier expressed himself on the subject as follows: " Cette derniére observation nous conduit a des reflex- " ions sur l'usage du charbon et des matières char- " boneusses en général dans les réductions metalliques. " Servent elles comme pensent les disciples de M. Stahl, " a rendre au metal le phlogistique qu'il a perdu? ou " bien ces matières entrent elles dans la composition même " du fluide élastique? S'il étoit permis de se livrer aux " conjectures, je dirois que quelques expériences, qui ne " sont pas assez complettes pour pouvoir être soumisses " aux yeux du public, me portent a croire que tout " fluide élastique résulte de la combinaison d'un corps " quelconque solide ou fluide, avec un principle inflam- " mable, ou peut-être même avec la matière du feu pur, " et que c'est de cette combinaison que depend l'état " d'élasticité: j'ajouterois que la substance fixée dans " les chaux metalliques et qui en augmentent le poids, " ne seroit pas, a proprement parler, dans cette hy- " pothèse un fluide élastique; mais la partie fixe d'un " fluide élastique, qui a été depouillée de son principe " inflammable. Le charbon alors, auroit pour objet

Whether Bayen or Lavoisier first denied phlogiston?

* Priestley on Air, i. 132.

" principal

"principal, de rendre au fluide élastique fixé le phlogistique, la matière du feu, et de lui restituer en même temps l'élasticité qui en dépend*." M. Bayen published his Experiments on Mercurial Precipitates, in the Journ. de Phys. for 1774, from which, as far as I can judge from the notes which I formerly made when I perused them, he drew conclusions similar to those of Lavoisier. Dr. Thomson in his Chemistry I. 101, ed. 2nd, says, that it was in consequence of hearing Bayen's paper read that Lavoisier was induced to turn his attention to the subject, which must surely be a mistake, as Lavoisier's experiments† on the same subject, were printed at least previous to the 7th of Dec. 1773. Dr. Thomson on examining the subject will I think find that he has committed another error in the same note. After relating in the text that Lavoisier revivified the calx of mercury by heat alone, he adds in the note that "this experiment was "performed by Mr. Bayen in 1774." I am led to believe from my notes that Dr. T. will find that the account of the experiments was at least published in 1775, as you state in your Journal xiv. 233, note.

It appears that Lavoisier was the first.

Short remark on Rey and Mayow.

As for the theory of Rey, I should be happy to peruse his book as an object of curiosity, but I do not wonder that his opinion should have excited little attention, when he alledges that "the increase of weight arises," from "the air of the vessel condensed, rendered heavy and "adhesive by the violent and long-continued heat of the "furnace‡." For my opinion of Mayow I must take the liberty of requesting your correspondent E. D. to peruse my remarks on his discoveries in the Med. and Phys. Journ. iii. 335 §.

I am,

Sir,

Your very obedient servant,

JONATHAN STOKES.

* Lavois. Opusc. 280. † 247.

‡ Journ. xiii. 82.

§ But qu. as to Hooke's claims in the theory so fully stated in his Micrographia and copied in our quarto Journal?

IV.

IV.

Extracts from a Collection of Papers on the Subject of Athletic Exercises. By SIR JOHN SINCLAIR, *Bart. M.P.*

[Continued from p. 77.]

THE case of Doctor Taylor of Croydon, narrated by Dr. Cheyne, is an instance of the power of regimen in eradicating one of the most terrible diseases incident to human nature. That gentleman had for many years been afflicted with the epilepsy to such a degree, as frequently to fall from his horse in the course of his business, and remain insensible on the road till picked up by the next passenger. Having observed that the lighter his food the less frequently did his fits recur, he confined himself wholly to bread and milk. This diet occasioning flatulence, he restricted himself to milk alone, of which he took about two quarts per day. Under this regimen he completely recovered his health and strength, so as to be able to play at cricket for many hours together, with hardly any perspiration. During fourteen years he experienced no recurrence of his fits, and at length died of a pleurisy, occasioned by cold caught from sleeping in a damp bed. I had once an opportunity of seeing this regimen adopted in a deplorable case of the same malady. The disease was not indeed cured, though much mitigated, and during the year it was persisted in, the patient considerably recovered his health and strength.

Doctor Taylor of Croydon was cured of epilepsy by milk diet.

When it is considered that persons most conspicuous for elegance of person, as well as for acuteness of intellect, are peculiarly liable to become the victims of the sure though slow-moving dart of phthisis pulmonalis, it becomes a very desirable object to possess some means of opposing the depredations of that scourge of our island. To effect this purpose it is requisite to be able to detect the earliest advances of that insidious disease. To discover any remedy that will remove tubercules, or cure ulceration of the lungs, if actually present, judging from the analogy of other diseases, is hardly to be expected. Without quibbling about the term hereditary disease, no doubt can remain in the mind of any man of observation,

Observations on those subjects who are peculiarly liable to pulmonary consumption.

that children are not only prone to the diseases of their parents, but are even peculiarly liable to the diseases of that parent to whom they bear the closest personal resemblance. That children particularly resemble their parents in the structure and formation of their nails, has not been so generally remarked; and a child will very generally be found to partake most of the constitution, and consequently to be peculiarly liable to the diseases of the progenitor to whom it has the greatest similarity in this particular part of the body. A certain conformation of the nails affords also a strong indication of the disposition to phthisis. In persons of the consumptive habit, the nails are in general large, long, of a fine texture, and curved over the ends of the fingers, the last joint of which appears as if enlarged or thickened. When this peculiar structure of the termination of the superior extremities is found combined with fine sound teeth, a flaccid skin and high shoulders, little doubt can remain of the existence of disposition to phthisis, whether the individual be of a fair or of a dark complexion; and if we find that any hereditary taint is present in either of the parents, it is almost certain that their offspring will ultimately become the victims of this disease.

Remarkable similarity of children to their parents in the form of their nails.

Description of that structure which indicates a disposition to consumption.

Of the effects of a regimen of the farinacea, combined with milk and fruits, in subduing the early attacks of phthisis many examples are recorded; and there would probably be many more, were an appropriate regimen adopted rather with a view to prevent than to cure this disease. Hence the utility of noting every mark that can lead to the detection of a tendency to this disease, and the consequent adoption of a plan calculated to prevent its earliest attacks.

It may be subdued by regimen.

Some experience has induced me to be of opinion that more may be done to counteract the predisposition to this disease than has hitherto been effected. The surface of the lungs and that of the skin are both secreting organs, the functions of which mutually compensate each other; a languid and inert condition of the skin is necessarily attended with a diminution of cutaneous perspiration, to make up for which a larger share endeavours to escape by the lungs, and this increased effort may well be supposed to lay the foundation for disease. The hypothesis

More may be done in this respect than has hitherto been supposed,

thesis is supported by the well-known facts that sailors, ploughmen, butchers, and all persons whose occupations are carried on in the open air, and whose perspiration is therefore free and copious, enjoy a remarkable exemption from pulmonary complaints; on the contrary, two thirds of the working tailors of London, taking them as an example of the sedentary class of artificers, are believed to die of pulmonary consumption. Let us then endeavour to remove this inert condition of the skin, not by internal sudorific medicines, which would only relax it more, nor by keeping the body constantly bathed in an atmosphere of its own perspiration by casing it in flannel. Rather by daily exposure to the air bath, during which the surface of the body should be rubbed with a hard flesh brush, either by the hands of the patient, or by those of an assistant till the whole skin glows. From a sedulous attention to this practice, which when regularly persisted in becomes very grateful, combined with a light dry diet, and unremitted exercise in the open air, I have seen such an alteration produced in the constitution, as leads me to hope that much may be effected in repelling the attacks of this disease, if the proper means be sufficiently early employed.

— principally by an attention to the state of the skin.

Should this sketch of the mode of training the antient *Athletæ*, which suggested these few hints concerning the influence of diet, air, and exercise, in counteracting certain diseased states of the constitution, coincide with your plan of diffusing a more general knowledge of the means of preserving health, and preventing disease, I trust you will accept of them as a mark of my respect for that wish to ameliorate the condition of mankind, which appears on this occasion to have directed your efforts.

Conclusion.

I am, Sir,
Your most obedient servant,
A. P. BUCHAN.

Percy Street, *London*,
20*th March*, 1806.

P.S. The preceding observations being intended to indicate the physical changes possible to be effected in the human constitution, by a peculiar course of diet and exercise,

The moral effects of boxing, &c.

cise, combined with exposure to a pure air, persisted in, during a time given, all remarks on the moral effects of pugilistic exhibitions, to which such a course of training, forms a necessary prelude, have been intentionally avoided. This subject has lately been discussed with equal acuteness and propriety by Dr. BARDSLEY, in "A Dissertation on the Use and Abuse of popular Sports and Exercises," published in the last volume of the Memoirs of a Literary and Philosophical Society at Manchester, which, had it fallen into my hands before this account of the mode of training the antient *Athletæ* was transmitted to you, would have saved me considerable trouble. The reader will there find the different effects produced on the public mind by the exhibitions of human prowess, displayed in the practice of boxing, well discriminated from the consequences of committing acts of cruelty on the inferior animals, such as bull-baiting, throwing at cocks, and other execrable practices of a similar kind, which have been most improperly denominated sports. Ferocity of manners, and brutality of conduct, are the invariable consequences of indulging a propensity to witness such exhibitions. In England, where the art of boxing is particularly exercised, the number of persons who fall sacrifices to personal quarrels, or become the victims of resentment, are few indeed; whereas, it has been calculated, that at Rome a thousand persons are annually murdered by the stiletto of the assassin, and the proportion is probably not less in Spain and Portugal. In the southern counties of England, where the mode of deciding private quarrels among the common people, by an appeal to manual combat, is peculiarly prevalent, instances of their terminating in death are very rare. In the northern counties, on the contrary, where, when men fight, they take every unfair advantage, the loss of life is by no means uncommon, and the verdicts of man-slaughter occur so frequently as to have repeatedly excited the indignation of the judges. It is even stated, that since the practice of fair boxing has been in some measure introduced into the northern parts of this country, by the example of the itinerant teachers of the pugilistic art, instances of murder have become less frequent.

—have been well discussed by Dr. Bardsley.

Fair combat produces generosity and less mischief

—than vindictive struggles.

The pain inflicted and suffered by the persons engaged in these contests have caused them to be stigmatised by many humane persons, as cruel. But to judge of the feelings of the combatants by those of the spectators, is a very inadequate criterion. It is an acknowledged physiological truth, that the simultaneous actions of voluntary exertion, and of sensation, are in great measure incompatible with each other. Hence the utility of the bullet in the soldier's mouth, who is suffering punishment: by strongly exerting the muscles of mastication on this unyielding substance he diminishes the sensation of pain. Even our immortal bard appears to have been acquainted with this fact, when he makes Henry the Fifth desire his soldiers, previous to mounting the deadly breach, to

The efforts of combat diminish the sense of pain.

> " Stiffen the sinews, summon up the blood;
> " To set the teeth, and stretch the nostril wide,
> " Hold hard the breath, and bend up every spirit,
> " To his full height."

Such is the condition of persons engaged in a boxing match. And many who can contemplate the gallantry and spirit displayed in a contest of this kind, with considerable satisfaction, would shrink with abhorrence from the spectacle of a man beaten in like manner, were he at the same time deprived of the power of resistance.

It is also matter of common observation, that a man, in possession of a robust and vigorous constitution, suffers much less pain from a certain degree of injury than a person in a more feeble state of health. Carry this a little farther, and we find a delicate lady, whose flaccid muscles hardly suffice to support a debilitated frame from one chamber to another, yet highly susceptible of pain from the slightest external injury, and suffering almost annihilation at the sudden clapping of a door. It would seem, therefore, as if the force and irritability of the muscles, and the susceptibility of the nerves were in the inverse ratio of each other. The effect of a course of training appears to be to augment the quantity, and irritability of the muscular fibre, and at the same time, to diminish the morbid sensibility of the nervous system. And I think it is advancing a step in physiological know-

Robust constitutions suffer less from violence than the weak and irritable would do.

Training gives this vigour.

ledge, to have ascertained the means of augmenting or diminishing these opposite states of the living body.

Argument respecting pecuniary motives.

It might indeed, be desirable, that the persons who engage in these public contests were less influenced by pecuniary motives, and that there was less of the spirit of gambling connected with them. A rigid adherence to the rules of the combat, which chiefly consists in abstaining from taking any unfair advantage of an antagonist, is particularly attended to in a regular boxing match, and by such examples this generous feeling is supported and diffused among the mass of the people. Were the victor not rewarded by some prize, or testimony, of his superiority, the practice would probably soon fall into disuse.

If boxing were attended with neither pain nor danger, the discipline would not produce that steady courage which our countrymen have so often displayed.

Dr. Bardsley has proposed, in order to prevent injuries, that these combats should be carried on in mufflers, or stuffed gloves. The preparatory exercises, it is well known, are always managed in this manner. But an important part of the practice of boxing consists in that cool and steady courage which enables a man to endure a certain degree of corporeal suffering with patience; and in a command of temper, which preserves the presence of mind, undisturbed, amid pain and danger. This cool intrepidity constitutes the characteristic feature of British bravery; and whatever may be the evils attendant on prize-fighting, they are more than compensated, if it be allowed that such exhibitions tend to diffuse and support a spirit of this kind, among the inhabitants of the British Isles.

V.

Reverie; considered as connected with Literature. By the Rev. Johnson Grant, A.B. *of St. John's College, Oxon. From the Manchester Memoirs, Vol. I. of the Second Series*.*

Explanation of reverie, or the act of the mind in which surrounding objects and immediate pur-

It is a frequent process, and often one of the highest pleasures of the mind, to become insensible to the pursuits in

* Though the present memoir cannot with the most decided propriety be considered as belonging to Natural Philosophy, Chemistry,

in which it is more immediately engaged, and yielding to impressions which lead to more interesting trains of ideas, to suffer itself to be carried by them to an imaginary contemplation of distant scenes, or speaking over of former conversations;—to a recollection of past transactions or anticipation of future enjoyments. This mental observation is known by the name of Reverie: and is also expressed in common conversation by the emphatical metaphor—absence of mind.

suits are disregarded for more interesting musing.

Without entering into the question how far volition is concerned; whether the mind is active or passive in a state of reverie, it will not be improper, for the sake of imparting clearer ideas on the subject, to draw a parallel betwixt reverie and abstraction, according to the common acceptation of the terms. Abstraction is the act of attending closely to the object of study, which is present to us:—Reverie is the state of being drawn away from an observance of that object, by other reflections. The one indicates strength; the other a degree of weakness of mind:—abstraction is an effort to collect our thoughts: reverie consists in their being let loose, to wander whithersoever they will. Abstraction is a steady and continued act of pondering on the object before us. Reverie, as it is to be considered in this paper, consists in a want of the power of abstraction.

Reverie differs from abstraction.

In abstraction the mind is strongly fixed by choice on one present subject: in reverie it is weakly surrendered to the wanderings of fancy.

It is a want of abstraction.

Abstraction resists the impulses of external objects, which have a tendency to disturb the train of ideas in study. Reverie surrenders the mind to these impulses, and to the new train of ideas, (foreign to the immediate subject of contemplation) which they introduce. Abstraction is peculiar to the philosopher:—reverie to persons of sensibility and genius, uncorrected by strength of mind. Abstraction is the habit of the diligent. Reverie, the trifling of the idle*.

Powerful minds dwell by abstraction on their studies.

Light minds are diverted by reverie.

Every

mistry, or the Arts, yet its importance to all scientific and studious men leaves me no doubt that it will be acceptable to the readers of this Journal, whose progress in knowledge, and consequently the advancement of the sciences, must be promoted in proportion as their researches are guided by sound reason and an attention to the processes of the mind.

* It may, in some cases, at first seem doubtful, whether to refer certain

Manner in which the mind becomes absent, &c.

Every man is conscious that his mind is often imperceptibly conveyed away from the objects that are presented to his senses, and led to other catenations of ideas. Among these it ranges for some time, till at length, in a manner apparently inexplicable, it perceives itself brought back to its immediate employment: but is equally at a loss to explain how it broke loose, how long it has been absent, or what has occasioned its return.

Medical views.

Physicians, who have treated this mental infirmity as a disease, have confined themselves to a description of the constitutional frame, which renders us liable to it *. Having

Reverie of the Poet.

certain operations of the mind to the former or the latter of these terms. Poetry is one example—But a little reflection will solve the difficulty. Some of the poets' finest ideas may be derived from reverie:—but to embody them in words, to give them a local habitation and a name, close abstraction is certainly required.

Two kinds of reverie.

It may, also, be proper to observe, that there are two distinct species of reverie; each of which interrupts study. The one is unconnected with the object of our study, and is occasioned by a strong impression on our mind, which disturbs the power of attending to another subject: as if after witnessing an execution, I should attempt to read a book of philosophy, the horrid spectacle would in this case intrude upon my thoughts, and render attention impossible. The other species arises from the subject, and is frequently produced when the mind is at ease. Cato's Soliloquy on reading Plato's Treatise on the Soul's Immortality, may be supposed to be an example of it:—and this species of reverie may easily be confounded with abstraction.

The sensorial power employed on reverie diminishes irritability,

* Dr. Darwin, vol. I. p. 361, says that " people with increased sensibility, who may be known by high coloured lips, dark hair, and large eyes, are most liable to enthusiasm, delirium and reverie. In this last affection, they are seen to start at the clapping of a door, because the more intent any one is on the passing current of his ideas, the more is he surprised at their being dissevered by external violence. But owing to the great expenditure of sensorial power on these sensitive motions, it follows, that there will be a deficiency of it in the irritative, which will be performed with less energy.

— and renders us less sensible to surrounding objects, &c.

" Hence these persons do not attend to slight stimulus; but when a stimulus is great enough to excite sensation, it excites greater sensitive actions than in other constitutions. This is the case in delirium or inflammation.—Thus persons addicted to reverie are absent in company;—sit or lie long in one posture, and in winter have the skin of their legs burnt in various colours by the fire. They

ing omitted to analize the method, by which mind and body act and re-act on each other, they have failed to trace the disease to its source; and in point of remedy, have left it where they found it.

When the attention is engaged by abstraction, the organs of sense become inactive;

In the course of reading or reflection, the subject which engages us may be a task, or a pleasure; it may either be indifferent to us, or deeply interesting. If it be of the latter description, (or even in the case of the former, if we happen to possess a strength of mind) attention will be collected from every quarter, where it may usually be dissipated, and gathered to this single focus. It seems to leave the organs of sense;—which, hence, become callous to impressions, at other times forcibly perceptible. A bell may toll, and the hail may rattle on their windows; but both may be alike unheard. To this state of the mind, philosophy gives the name of abstraction.—If, on the contrary, I have a more favourite study than that in which I am engaged; or if, when I am engaged in study, there be some pleasure which I expect or have lately enjoyed; or some misfortune which I apprehend, or have lately sustained, dwelling upon my mind: I shall find it difficult to fix my attention—my thoughts will be perpetually recurring to this more interesting subject; my inclination to wander, and my desire to improve will carry on an equal contest; and I shall discover, on laying aside my book, that I have been reading one thing, and pondering on another. This double operation of the mind, constitutes that species of reverie which is peculiar to literary persons.

—but some prevailing object may draw the mind into reverie.

External impressions may draw the mind from its subject.

Our train of thought is disturbed, when any of our senses is acted upon by some quality in an external object, which tends to introduce a new series of reflections.

They are fearful of pain; covet music and sleep;—and delight in poetry and romance." As the motions excited in consequence of increased sensation, are more than natural, and thus expend a greater portion of sensorial power, the voluntary motions, like the irritative, are less easily exerted—Hence the persons we have been describing are indolent with regard to all voluntary exertions, whether of mind or body. They are also known by interrupting others in discourse with irrelevant observations. Deaf people adhere longer than others to one subject, as their train of ideas are in no danger from one inlet of disturbance.

Thus,

Thus, distant music may draw away attention from the book we peruse, to a scene, where the same sounds were formerly heard by us. Or, in the course of reading, we may meet with a passage, which suggests reflections irrelevant to the main subject. From these, when the mind is conveyed to them, the transition is easy to others, with which they are connected; and in this manner fancy may rove, for an unlimited time, through an unlimited range of ideas. The ocean, for example, may be introduced as a simile, illustrative of a metaphysical argument. Fancy will be drawn for a moment to the ocean, and if we have ever beheld it, or crossed it, the incident will present itself.—We then insensibly relinquish our employment to think on the storm which endangered our life; or on the country and friends, from whence the vessel conveyed us. May not a similar process rouse us from this trance, and recal us to the occupation we had left?—May not a new and unusual impulse upon any organ of sense, startle and remind us, that we are trifling with time?—May not the train of ideas, furnished by the reverie itself, lead us back to the very subject which engaged us, prior to its commencement?—In either way the reverie will be terminated. The firing of cannon may break in upon my fit of absence. When once awakened, but not till then I become conscious that I have been guilty of relaxation from the vigilance of attention, and return to my study, pleased, perhaps, with the excursion, but not without dissatisfaction on account of my loss of time. The same effect may be produced in the instance of the simile already mentioned, if the associated ideas to which the simile of the ocean had led me, taking a retrograde direction, conduct me back to the primary subject of comparison.

Instance of mental wandering.

Reverie may terminate itself, or be broken by external events.

When listening to the discourse of an orator, or lecture of a teacher, we digress in a similar manner, and are recalled by a look from the speaker;—by a pause;—by a sudden transition; a new figure; or a felicity of diction or of thought. This reflection may serve to analize the art of keeping attention awake in others.—It may recommend the impressions we have enumerated, as useful expedients in oratory; and explain the principle, which makes

The look and action of an orator fix the attention and prevent reverie.

makes us wish to have a public speaker in our view, while we are listening to him.

When the habit of mental absence is sufficiently confirmed to constitute a disease, the appulses of external objects, which would interrupt reverie in stronger minds, are found to strike upon the senses in vain. A man is mentioned in Zoonomia, who, during the paroxysm of reverie, was reciting some lines from Pope, one of which he had forgotten: it was several times ineffectually shouted in his ears; till at length, after much labour, he recollected it by his own efforts. Yet though such appulses do not destroy, they sometimes harmonize with the waking dream. In this case they excite attention; and the reverie, without being broken, insensibly glides into subjects connected with these appulses. In the work we have just now quoted, is an interesting account of a young person, who, while lost in reverie, heard a passing-bell; and without being recalled to a consciousness of wandering thought, was soon after heard to say, "I wish I were in my grave;"—and pulling off her shoe—"A little longer and a little wider; and even this would make a coffin."

Mental absence in the extreme is a disease

—which is not removed by external impressions;

—though they may be perceived.

Such are the various kinds and degrees of reverie. The enumeration of them was necessary to the discovery of those means by which this mental affection may be regulated or remedied. The subject is of the highest importance to those who are entering upon their studies; since, as it is an argument against wasting much of our time in sleep, that we may be said only to live while we are awake;—so, with regard to letters or business, it may be asserted, that we do not study all the hours we number at our desk, but those only, during which the vigour of our minds has been exerted in our proper employment.

It is of great importance to studious men that they should not indulge reverie.

There are several methods by which reverie may be regulated and modified.

1st. The abstraction of excitement produced by external stimuli, will, in most cases, give a preponderance on the side of study, and thus be inimical to reverie. A walk along the shore is more favourable to abstraction, than in a garden or terrace, where the frequent turnings interrupt reflection. Philosophers in general have shunned

Reflections on the causes which prevent or which favor reverie.

Solitude.

shunned the town, that its noise and bustle might not disturb their meditations. Nevertheless, we have heard of some, whose minds were more active amidst the uniform, mingled hum of the throng, or the noise of a carriage, than in more tranquil scenes. This may be accounted for by asserting, 1st. That such uniform sounds may be from habit, associated with abstraction, as opposed to reverie; and that it is only by sharp, sudden impulses, and not by uniform and accustomed sounds, that abstraction is discomposed; and 2dly, That, when this is the case, the sounds in question will drown all others, and thus weaken the influence of their excitement in disturbing abstraction, and producing reverie. Here, however, a difficulty arises. If I remove myself to silence and solitude for the purpose of philosophical abstraction, should reverie by any means find its way to my mind, and experience proves that no silence and no solitude can exclude it,—will not the absence of excitement from external objects be favourable to the continuance of those idle musings, which I have taken pains to avoid? The first object of a student is, to preclude the advances of reverie; but when its spell has stolen upon him, external stimuli become desirable in order to dissolve it. Hence a retreat into the shade will only facilitate reverie; unless we carry along with us a fund of information, on which we may ruminate: an object of science to occupy and interest us; and an inherent vigour of mind, which shall enable us to resist the slighter impressions on our senses, from which the deepest retreat is not exempt. The superstitious dreams which are known by the name of second sight, are found amongst the most uninformed of mankind, in a country where the absence of disturbance might favor the highest speculations in science. The beach of the sea, which Plato chose as the fittest place for philosophical instruction, has in our own country become the favourite haunt of the indolent and the unthinking.

Town life.

Whether retreat be most favourable to reverie or to abstraction.

Second sight of the Highlands of Scotland.

Reverie is lively or serious according to its cause.

Objects and circumstances may be so disposed as to give to reverie a pleasing or pensive, and as we shall presently see, a refined or inelegant direction. I believe it is unnecessary to ask, whether the mind will not be more apt to depart from serious meditation in a gaudy chapel, than

than in the solemn gloom of a cathedral. It is remarked by an eminent medical writer, that light, introduced by opening the window-shutters, gave a gayer cast to the ideas of a patient who laboured under reverie. The study of Tasso was a Gothic apartment; and he fancied his familiar spirit to converse with him through a window of stained glass.

If we can contrive to effect, during the reverie, a frequent re-action of any circumstance connected with our original employment, we shall, by this means, frequently bring back the mind from its excursion. It has been asserted, in favour of the liturgy of the Church of England, that, by being broken into short prayers, and interspersed with frequent responses to be spoken by the people, it is accommodated to the frailty of human nature, and has proved an excellent method of recalling the mind, too apt to wander, even from its most important occupations, and its most sacred duties.

The English Liturgy is calculated to fix the mind, and prevent reverie.

A house of worship is certainly the most suitable place for acts of devotion. The mind is no sooner inattentive, than it sees around it objects connected with religion, which upbraid its weakness and check its aberration.

I now come in the last place to enumerate the remedies I would propose for the diseased state of the mind, which has been the subject of the present dissertation—and these all rest upon a single principle. The "vis insita" of the mind, inclining, by a voluntary exertion to the side of study, constitutes the power of resisting the seducements of external stimuli, and of bidding defiance to reverie:—and as reverie has been shewn to proceed from mental relaxation and debility, so, whatever produces mental vigour may be pronounced an antidote to it.

Study is a remedy for this mental defect,

Now mental vigour is, in great measure, regulated by the strength of the body; so that literary persons, who are desirous to preserve their minds in a proper disposition for studying with the greatest benefit, should remember, that with respect to exemption from reverie, it is only "in corpore sano" that the "mens sana" is to be found.

—and so is bodily vigour.

The first remedy accordingly which I shall mention is, frequent and habitual exposure to a pure and bracing atmosphere,

This is promoted by exposure to the open air,

atmosphere. The influence of different states of the atmosphere, in sharpening or hebetating the powers of the mind, was so well known to the ancients, that to this cause they sometimes ascribed the diversities of national character. "Inter locorum naturas quantum intersit, vidimus. Athenis, tenue cœlum; ex quo acutiores etiam putantur Attici:——crassum Thebis, itaque pingues Thebani." A sharp and salubrious atmosphere, by invigorating the frame, will thus render the mind alert and active, and intent upon its employment.

—and by temperance,

Another important remedy for habitual reverie is temperate living, equally removed from abstinence and excess*. For too great abstinence is a direct cause of mental weakness; while repletion renders body and mind sluggish and torpid.

—and also by stimuli;

It is the property of stimulating articles of diet to bestow a temporary vigour, a strong action of the system, which is soon followed by exhaustion. Men of genius, as Brown and Erskine, have accordingly been reported to have swallowed quantities of laudanum, previous to any occasion when it was necessary to call forth all the powers of their mind. Not content with the moderate and judicious tonic of a frugal and healthful meal, they have improvidently applied violent stimulants. But let not this fact be thought to militate against our argument. As long as the stimulus acts, the mind is, doubtless, invigorated. It is enabled to resist the attack of impressions foreign to the subject in which it is engaged;—impressions, which perpetually attempt to lure it from that subject into the mazes of reverie.—But, as the force of the mind is then increased, by borrowing to-morrow's energy for the service of to-day, to-morrow will be spent in languor. The consequences indeed are less pernicious to the orator than they were to the physician. His mind may recruit its strength before a new exertion of its faculties is demanded. But the lecturer, whose labours were quotidian, must have entered his class with faculties

— but these destroy the system.

* It is after dinner that our poet Cowper, describes himself as pleased with the movement of his shadow on the ceiling, and as thrown into a train of musing by the objects which his fancy beheld in the fire.

enfeebled

enfeebled and incapable of exertion. Finding his spirits sunk as much below the point of exhilaration, as his last doze had raised them above it, he increased the quantity of stimulus in a progressive duplicate ratio:—The unfortunate Brown at length fell a victim to dram-drinking.

The Turks, who take opium, are addicted to reverie.

The Turks, who chew opium in large quantities, are much addicted to reverie. Some traveller relates, that he has observed a native of Turkey sitting from morning till evening in the same posture, poring in a stream where he had fixed a bottle, for the sake of being thrown into a pleasing rumination by the bubbling noise it made with the water.

Long-continued study is unproductive.

They who have indulged their minds in a habit of inattention and wandering, are apt to prolong their time of study, that they may finish, before they rise from their desk, the task they have allotted for the day: under the impression that they are by this means redeeming the time they have lost in dissipation of thought.

Much of the time of him who takes no exercise is useless.

This is a mistaken economy, and proves no saving of time in the end. He, who, greedy of knowledge, neglects to accustom himself to regular bodily exercise, will find many of the hours which he has passed at his desk, to be undeserving of being computed with the hours of actual improvement: and will thus become sensible, that if a certain portion of time had been given to exercise, the hours of his actual improvement would have been more in number. When the body has been sedentary and indolent, the faculties make fruitless attempts to grasp the objects of their study.—This is the case in reading: it is still more so in composition. With great wisdom, therefore, did the Greeks mingle gymnastic exercises with the study of philosophy. In the morning, after the spirits have been recruited by rest, the mind being (with the body) fresh and vigorous, is not disposed to deviate from the subject presented to it. It was accordingly at this time of the day, that the kings of Egypt transacted all their public business.

Evening studies are of little value.

In the evening these circumstances are altered. The fatigue and the meals of the day, and the recurrence of the images that have passed before the senses, are inimical to the vigorous stretch of intense thought. Brutus used

to

to read in his tent, at midnight when his frame was debilitated, and his spirits were exhausted by a long march, and by the heat of the morning;—when his mind was unstrung, and prevented by weariness from exerting its powers with one fixed direction. May not the spectre have been a creature of his imagination when thus predisposed for reverie? when his ideas consisted of confused conceptions, furnished partly by his book and partly by his fancy. And will it be deemed extravagant to conjecture, that the passage he was reading may have been the story of the dying Bramin, who prophetically warned Alexander that they should meet at Babylon?

The spectre which appeared to Brutus.

Fact supposed contrary to this.

I am aware, that the mind, when deeply engaged in study, sometimes overcomes sleep, and assumes a new vigour at a late hour of the night. In this case, certain degree of fever, in other words, of increased action, has taken place; which will be followed, and proved to have existed, by commensurate mental debility and nervousness.

"Some," says a modern author, "look over what they want to remember, immediately before going to sleep at night, because then the mind is not afterwards busied about any ideas that might drive it away: or in the morning on first getting up, because the mind is not then pre-occupied with any ideas which may hinder the subject's getting fast hold of it."——*Gerard's Pastoral Care.*

*On the whole, whatever destroys the balance between body

Diseased sensibility and impaired muscular vigour are concomitant.

* It is a law in the animal œconomy, that sensibility accumulates as irritability is exhausted: in other words, that the nervous fibre becomes more sensible to impressions, as the muscular fibre becomes less so, and vice versa.—Preternatural or diseased sensibility is not found in the strong labourer so much as in the hysterical and debilitated female. The author of this essay, who can encounter without mental pain, any scenes of distress which he may witness in his professional character, in the morning, when the frame is in tone, has observed in himself a propensity to be much affected by them, when presented to him after fatigue and long fasting. Whatever accumulates sensibility, increases the mind's liability to be acted upon by external stimuli, and carried away by them from its steady observance of the object of its study. And since the exhaustion of irritability produces this effect, the propriety of the foregoing injunctions is evident.

body and mind, whatever impairs the firm tone of the animal fibre, ought to be studiously avoided by those whose habits are literary. The debility subsequent to a debauch, a warm climate, fatigue, corpulency, are all favourable to reverie. And every thing that braces the fibre, and gives the system (not a sudden and artificial increase of action,) but permanent strength and exhilaration should, with equal care be resorted to.

Literary men ought to avoid all causes of debility, for these favour reverie.

But for the mental disorder, which has been the subject of our discussion, we must look, in the second place, for other remedies in the mind itself, when considered abstractedly from the body.

Mental remedie against reverie.

Much benefit will be derived from conquering a sickly taste for light and desultory reading, and abstaining from an immediate application to the fine arts. When they, who have indulged in such pursuits, engage in studies of more solid utility, they find the perusal of historic facts, or the prosecution of philosophical arguments, perpetually interrupted by the involuntary remembrance of their favourite and less severe employments. Mathematics is a science worthy of being recommended to youth, and, indeed, demanding the attention of all whose habits are literary; not so much for its own sake, or for that of the other sciences which cannot be understood without a knowledge of it, as on account of its implanting habits of abstraction and of bestowing the ability to fasten the powers of the mind upon any subject, and to pursue it till it is thoroughly investigated*.

To avoid light reading.

Mathematics recommended.

Here, however, a caution is necessary. Elegant literature and the fine arts, although thus paralysing to the mind when they are made the main object of pursuit, may in certain cases be called in with advantage, as remedies for reverie. When the mind is under the influence

But elegant literature may be considered as an exhilarating refreshment.

* In comparing the effects of the different leading branches of education at our two universities, it has been remarked, that persons who have studied at Cambridge, adhere long and steadily to an argument, in conversation; while Oxonians, whose pursuits are more elegant than philosophical, are content with a more superficial examination of many subjects; but afford greater pleasures to their companions, by the desultory variety of the ideas which they communicate.

Oxford and Cambridge students compared.

of any passion, joy, surprise, grief, indignation, which deprives it of the ease and exemption from solicitude requisite to its applying with effect to abstruse researches or what is called serious reading,—it will then be its philosophy to lure attention into the paths of literature, with the elegant classic, or interesting narrative;—with the works of poets or dramatic authors; and with composition on its favourite theme:—stimulants powerful in calming the soul, and charming sorrow into tranquillity, when rarely and prudently applied; but which would lose their effect, if they were daily administered.

Objects which seduce attention are to be avoided.

Another expedient, which it will be prudent to adopt, is the removal of our place of study, beyond the reach (if possible) of every object and circumstance which being presented to any of our senses, is apt to seduce attention. The fragrance of flowers, the voice of music, the portrait of a friend, the hum of men, has each its train of associated ideas, to pursue which, the mind of the student may insensibly be drawn off from the object of his study. And if the student wishes to obtain a depth of thought, a closeness of reasoning, dispatch, or perfection in study, he will reserve these luxuries for the hour of relaxation. It was one of the maxims of Lycurgus, that ornaments should not be placed in the council halls, as they tended to alienate the attention of the judges, when listening to the pleaders.

Art of memory.

The art of memory has been said to be the art of attention;—the art of preventing the operations of the mind from being broken by short reveries, to which weak minds are decoyed by every sound or sight that passes. It is possible for a Newton to be so deeply absorbed in thought, and to have practised abstraction so thoroughly, that the firing of a cannon will not break the train of his ideas.—But common minds, conscious of their inferior strength, and of their greater aptitude to be interrupted, should cultivate letters in places where the fewest and the weakest stimuli are applied;—in the shade, remote from noise, and not exposed to passing objects. Colbert's having said that his mind was always most active in the midst of Paris, if not fully solved in the former part of this essay, may be considered as a proof, that that minister possessed a warm imagination,

Remarks on men supposed capable of abstraction in all situations. Newton, Colbert.

imagination, guarded by a vigorous intellect;—that he was willing to give loose to the wanderings of fancy, in the midst of rural leisure: but ever associated the recollection of want of time and fulness of occupation in the metropolis, with the first aberration of thought from the subject he had before him.—Besides, it is reasonable to suppose, that the studies of Colbert, when in Paris, were confined to the politics of the day; a subject which, by engaging every passion, must have entirely engrossed attention, and deadened the force of external stimuli: whereas his rural lucubrations had, probably, for their subject, topics of speculative philosophy, less interesting, less relating to self and immediate concern; and therefore less endowed with the power of detaining the mind, prone to her favourite sallies of digression from her main employment. Nothing can be more absurd than an attempt to unite a life of literature and of gaiety.—The remembrance of glaring objects and tumultuous pleasures, perpetually obtruding itself on the mind, will soon convince the scholar, that his efforts to make thought and dissipation of thought meet in the same mind are vain.—The recollection of past, or anticipation of approaching frivolities, makes abstraction a painful and violent, I may safely affirm, an impossible exertion. The conceptions of an effeminate imagination unsettle the mind; —they float upon and confuse the ideas supplied by study.

Literature and diversions cannot be combined.

Indeed a habit of study and abstraction is the most powerful precaution that can be adopted against the intrusions of reverie.—Reverie resembles the enemy of mankind. Resist it, and it will flee from you. The oftener and the more vigorously you oppose it, the less frequently will it recur, and the weaker will be its attacks. While the idler and the man of pleasure cannot peruse even a few pages of a novel without mental weariness and wandering;—the student will in time bring his mind to the ability of prosecuting for many hours, the deepest reasoning, seldom interrupted by reverie, and never overcome.

Habits of abstraction gradually destroy the habit of reverie.

When speaking of the force of habit, we cannot fail to recommend the habit of extemporaneous speaking. When a man finds that his words must flow in an uninterrupted

Extemporaneous speaking.

succession, and that his ideas must keep pace with them, he will have no leisure for idle musing.

The various circumstances by which attention may be fixed to a subject.

Let us suppose, a contention held between the employment which engages us on the one hand, and the stimuli that act upon our senses on the other. Each strives to draw the attention of the mind towards itself. If the employment be pleasing, or if several of the senses, instead of one, be engaged in it, we may consider it as the stronger party, as having the greatest force on its side. Attention would be less apt to waver if we were to transcribe, than if we read a passage in any author; if we saw a drama performed on the stage, than if we perused it in the closet; or if we were present at a parliamentary debate, than if it only reached us through the cold medium of a newspaper. When the mind therefore is agitated, and incapable of intense application, it will be well to betake ourselves to any occupation of which we are enthusiastically fond. Whence arises the fluency of the unlearned itinerant preacher. It is to be ascribed to the two last principles on which we have expatiated, habit and enthusiasm.

An expedient to prevent wandering of mind.

It often happens to those who devote much time to reading or composition, that as soon as their reverie commences, they unconsciously remove their eyes from their book or writing desk to some particular spot in the apartment which may be favourable to mental wandering, or associated with it by habit. Now, if they would previously affix to the idea of this spot, the idea of consciousness that they have departed from their proper occupation, they would probably be enabled in this manner to check the fit of musing at its commencement, and to save the time which would otherwise have been squandered. No one is unacquainted with the story of the orator, who could not plead without holding a string in his hand, for the purpose of recalling his wavering thoughts. The biting

Biting of the nails.

of our nails, during composition, may be referred to the same cause. We associate the idea of this practice with that of our first and main employment, so that the former is never present without the latter;—and any new train of ideas obtruding themselves on our study are kept at a distance by the recurrence of the practice alluded to; which

which we have previously identified with the recollection of our original object of contemplation. As nail-biting is intended to fix abstraction, drumming with our fingers is a practice, by which we promote reverie. This it does partly from habit and partly upon a principle already mentioned; namely, that a gentle uniform stimulus draws attention from all others, except such as are sudden and violent; which will dissolve any reverie, however interesting, and however artfully promoted, unless in a diseased state of the mind.

Drumming with the fingers.

If, therefore, we find that this last mentioned practice is favourable to the continuance of our minds in the regions of imagination, we must frequently, when we have greater command over our thoughts, study to connect and blend the practice with internal disapprobation of our indolence.

If, however the habit of reverie have been too deeply fixed in our minds to be entirely eradicated;—or if (as is the case with many) we be unwilling to part with this pleasing weakness, and consider the moments spent in such desultory musings, as the most delightful of our lives, we ought still to be anxious to regulate them in such a manner as to prevent them from being either unprofitable or criminal.

If reverie be not dismissed it ought to be regulated;

We may hinder them from becoming unprofitable, by cultivating a taste for intellectual pleasures; by habitual application to a variety of branches of study;—and by frequenting the society of the learned or the refined. The reverie, which we cannot conquer, will thus be converted into a rational employment;—for taste and memory will direct it to subjects of science and utility.

or rendered profitable.

The best rules for preventing fits of absence from becoming criminal, will be found in that book, which is the highest authority on this part of the subject. Keep the heart with diligence, for out of it proceed evil thoughts;—the springs of conduct; the issues of life. Be strenuous in "casting down imaginations" that are contrary to virtue; and "bringing every thought into the captivity of principle." The authors of the book from whence these maxims are extracted, were aware, that it was impossible to put an entire en to the influence of matter

The reveries of a virtuous and regulated mind will be without reproach.

 over

over the mind, and to abolish reverie. They knew that as long as the human frame continued in its present condition;—"the corruptible body would press down the incorruptible soul."—They therefore enjoined the purification of the thoughts; in order that whenever matter should exert its influence upon mind, and force it into unconscious deviation from its employment, mind might be invariably led by inclination into the paths of innocent or pious musing.—Quinctilian relates of his son, that in consequence of his strong attachment to letters, no word escaped him in the delirium of a fever, that had not a reference to his favourite occupation. Thus when the scientific mind recovers from a paroxysm of reverie, it has the satisfaction of reflecting that its time has been well employed;—that if it has not been meditating some new effort of its powers, it has, perhaps, been dwelling on some elegant thought, or glowing description treasured up in study, or heard in conversation. And, in like manner, when the reverie of the virtuous man is at an end, he finds, that, while it lasted, he has either been forming a good purpose, or acting over in fancy, a benevolent deed.

if directed to letters or to science they will be contemplated with satisfaction.

Far different trains of thought pass through the imaginations of the ignorant, the vicious, the sensual. If their minds are not mechanically driven to recollections that are full of remorse and bitterness, the highest pleasures of their reveries are the remembrance of some frivolous enjoyment, or anticipation of the pampering of some base appetite. An Apicius will feast again in fancy on the banquet of yesterday. An Alexander's mind will leave the scene which surrounds it; "thrice to vanquish all his foes, and thrice to slay the slain." How far in frivolous minds a human passion will get the better even of devotion, may be seen by referring to our great dramatic bard.—

The vicious and sensual have criminal reveries.

"When I would think and pray, I think and pray,
To several subjects; heaven hath my empty words,
Whilst my invention, hearing not my tongue,
Anchors on Isabel."

Idle and unprofitable reveries may be also broken, by having our study hung round with portraits of heroes and worthies; of ancient and modern authors; of any who have

The ornaments of a chamber may be adapted to remedy this weakness.

have attained eminence or power, by mental activity and perseverance, and are calculated to rouse the slumbering mind to emulation and energy. And in like manner may we dissolve the spell of reveries, into which evil thoughts are apt to enter, by the pictures of a Saviour, or of a departed or sainted friend. Who would not return, with a blush, from whatever criminal conceptions he had hung upon, when he encountered the eye, and fancied that he beheld the frown of personages so sacred?

Reverie may perhaps be allowable as a relaxation.

To propose a total preventive or cure for the disease I have been considering, has neither been my aim nor my wish. The aim would be ineffectual, as long as mind and body depend and reciprocally act on each other, as they do in the present existence.—The wish would be the dictate of that cold philosophy, which seeks to shut up one inlet of those few, harmless delights, that heaven has apportioned to us, and that nature has commanded us to husband. Yet this riot of fancy should be seldom and carefully indulged. If it be sometimes allowable to slacken the reins, with which the mind is held attentive, never let us throw them entirely away;—for though it would be pedantry to suggest, that since moments thus passed, are inconsistent with our active duties, they ought without reservation, to be condemned;—we ought, nevertheless, to beware of every relaxation, which pre-disposes the mind to habitual inactivity.

Few minds can resist stimuli by abstraction; none can do it perfectly.

Stimuli may be increased to so intense a degree, that attention will be compelled to leave the fondest object on which it broods, and to obey their impulse. For although we have read, that Archimedes was solving a problem during the sack of Syracuse, that Newton was often insensible to his meals having been brought before him and removed; that Cicero calmly pursued his studies while his mind was dejected by domestic grief and harassed by public vexation;—yet it is certain, that pain or hunger, fear or sorrow, or joy, or any violent passion, will, in most minds, overcome the deepest and most philosophical abstraction.

The mind cannot overpower the senses;

Little credit is due to the story of an Italian philosopher's being so wholly absorbed in contemplation, as to be unconscious that he was upon the rack.—Let us call

to

mind an elegant sentiment of our master of nature, whose works every philosopher who reads them will often have occasion to quote.

> "Oh! who can hold a fire in his hand,
> By thinking on the frosty Caucasus, &c."

Nor is it fit it should.

Philosophers, nevertheless, there are who assert that man may in time become so perfect that his mind shall be unaffected by variations in the state of his body. But even were this improbability to be desired, it surely cannot be expected; for their mutual reliance is at present so great, that it justifies the conclusion, that mind will never become omnipotent over matter, until it shall be altogether independent of it.

VI.

Account of a Crane, with the Description of a Method of working the Common Chain in Machinery, so as to exceed Ropes in flexibility and strength. By Mr. Gilbert Gilpin, *of Old-Park Iron-Works, near Shifnal*.*

The common chain will answer every purpose of a rope.

FROM its simplicity of form, and facility of manufacture, the common chain, formed of oval links, has been in use from the earliest ages; and that it did not answer every purpose of a hempen rope in working over pullies, was not owing to its peculiar form, but from an error in the application.

Reasons why it has hitherto failed. It has a twist,

Every chain of this nature has a twist in itself, arising from a depression given by the hammer to each link in the welding†; and this circumstance, so trifling in appearance, is not so in its effects, and it has in consequence a perpetual tendency (even when reefed perfectly straight in pullies, and on the barrels of cranes) to assume a spiral form, which a plain cylindrical barrel, and the

* Communicated, with a model, to the Society of Arts, who awarded the silver medal and thirty guineas to the Inventor. See Vol. XXIII. of their Transactions, where the present article is extracted.

† The twist may be seen by holding the piece of the chain by one end, and viewing the links edgeways as it hangs down.

common

common pullies with semicircular grooves, are not in the least calculated to prevent. Hence the alternate links of the chain, in coiling round a barrel, or working over pullies, form obtuse angles in assuming the spiral form, bearing upon the lower parts of their circumferences, and forming as it were two levers, which wrench open and crush each other in proportion to the weight suspended, as well as prevent the freedom of motion in the links themselves, and thereby load the chain with additional friction.

—and its links tend to cut each other, when bearing on a barrel.

A still greater obstruction to the uniformity of its motion, is the tendency which the chain has to make a double coil as it approaches the middle of the barrel and crosses its centre, and that of the pullies at right angles, by means of which the chain is frequently broken by the sudden jerk caused by the upper coil slipping off the undermost.

Its coils will ride upon each other, and jerk when they slide off;

It is to these causes that all the accidents that occur to workmen and machinery from the failure of chains may be attributed (bad iron excepted), and which form the sole objection to their becoming a general substitute for ropes.

—and thus they will break

As a preventive to these evils, I have grooves cast in iron pullies, of sufficient dimensions to receive the lower circumferences of the links of the chain, which work vertically; those which work horizontally and form the gudgeon part of the chain (if we may be allowed the expression), bearing upon each side of the grooves.

The inventor prevents this by grooves in the pullies;

The barrels are also of cast iron, with spiral grooves of the same dimensions, at such distance from each other as to admit the chain to bed without the danger of a double coil; by these means the links are retained at right angles with each other, the only position for free and uniform motion.

—which admit the half of each alternate link.

The links of the chains are made as short as possible, for the purpose of increasing their flexibility, and they are reefed perfectly free from twist, in the pullies, and on the barrels for the same reason.

When applied in blocks, the grooves in the pullies prevent the different falls of the chain from coming in contact, and render plates between them (as in the

—and produce many advantages.

common way) totally unnecessary; the pullies are in consequence brought closer together, the angle of the fall from block to block considerably diminished; and the friction against the plates entirely avoided. Brass guards, with grooves opposite to those in the pullies, are riveted to the blocks, to prevent the chain getting out of its birth from any accidental circumstance. This method of working chains I first put in practice for Messrs. T. W. and B. Botfield, at these works in July last; and it is applied in the working of cranes capable of purchasing from ten to fifteen tons; in the working of the governor balls of steam-engines constructed by Messrs. Boulton and Watt, and in the raising of coal and ore from the mines, for which purposes ropes had before been solely used at this manufactory. In all cases it has performed with the utmost safety, uniformity, and flexibility; so much so that the prejudices of our workmen against chains are entirely done away, and they hoist the heaviest articles with more ease, and as great confidence of safety as they would with the best ropes.

Various successful applications.

The method is easily to be introduced.

The same method is applicable, at a trifling expense, to all machines at present worked by ropes, or by chains, in the usual way: and all the common chains now in use, may be applied to it with equal facility.

Experiments.

With a view of ascertaining the relative flexibility of ropes and chains, I wedged an iron pulley, thirty-one and a half inches in diameter, on the spindle of the pinion of a crane of the following description, viz.

Barrel, 30 inches diameter;
Wheel, 64 teeth;
Pinion, 8 ditto;
Top block, with three pullies of 12 inches diameter;
Bottom block, with 2 ditto, ditto.

A chain applied in this method is much more flexible and easy in its work than a rope.

To the large pulley I attached a small rope, for the purpose of suspending the weights in the hoisting of the different loads, and the results were as follow:

The

The Crane was loaded with	Took to hoist the loads when reefed with the Chain in grooved pullies*.	Ditto, when reefed with a half-worn tarred strand-laid rope, $3\frac{1}{2}$ inches in circumference.	Ditto, when reefed with the Chain promiscuously as in the common way.
lbs.	*lbs.*	*lbs.*	*lbs.*
First. . 2000	63	74	80
Second 1000	32	39	41
Third . . 500	17	21	22
Total . . 3500	112	134	143

The chain in the common way is less so.

The flexibility is inversely as these momenta, and proves the superiority of chains; for (on the average of the trials) with the chain in the grooves,

One pound raised . 31,25 lbs.
With a half-worn strand-laid tarred rope, three inches and a half in circumference, ... 26,11 do.
And with the chain in the usual way, only. . . . . . . 24,47 do.

It also appears (contrary to the general opinion), that chains are safer than ropes; for it is an established axiom, that those bodies whose fibres are most in the direction of the strain, are the least liable to be pulled asunder; and in our examination of the properties of a rope, we find that the strands cross the direction of the strain in undulated lines, and consequently prevent its uniform action thereon. A rope is subject to this inconvenience even when stretched in a direct line, but more particularly so when bent over a pulley, as in that position the upper section moving through a greater space than the under one, is acted upon by the whole strain; and hence the frequent breaking of ropes in bending over pullies, from the double strain overloading the strands of which the upper section is formed.

The chain is safer than a rope.

* All the experiments were tried with the same grooved pullies.

 The

The oblique strain from bearing is inconsiderable.

The links of a chain are subject to the transverse strain, where they move in contact; but as such strain is in proportion to the length of the bearing, it must be very trifling. All the links having axles of their own, *the chain moves simultaneously with the strain, and both are in consequence retained in continual equilibrio.* A chain in grooves will therefore sustain as great a weight when bent over a pulley, as it will in a direct line, and consequently is safer than a rope.

Chains are less affected by exposure than ropes.

A safe, uniform, and flexible method of applying chains in the working of machinery, has long been a desideratum in the arts; for they are but little affected by exposure to the weather, or the heat of manufactories, whilst either produces the speedy destruction of ropes.

——and last six times as long.

This discovery is of additional importance, as it substitutes a durable article for a very perishable one, and gives employment to our own manufactories at the expence of foreign importations.—The durability is at least six to one in favour of chains.

The author's crane has valuable improvements.

Though the drawing of the crane is chiefly intended to convey a proper idea of the new method of working chains, yet it will be found to possess several other advantages in point of construction, which are entirely new, and calculated to increase the safety and durability, as well as to lessen the expence of that useful machine.

The mortises of the transverse pieces are commonly distant from the gudgeons.

On reviewing the principles of a crane, we find that the gudgeons are the points of resistance to the machine and its load, and consequently the effect of the transverse strain upon the perpendicular, will be in proportion to the distance of the mortise, for the gib from the upper one; and that of the oblique strain, in proportion to the distance of the mortise for the diagonal stay, from the lower one.

——which requires a strength of timber in the upright piece.

Notwithstanding these circumstances are so evident, they are seldom attended to; for in general a large and expensive piece of oak, sufficient of itself to make a crane of double the purchase, forms the perpendicular; the gib is mortised into it, at eighteen or twenty inches from the top, to make room for the gudgeon, as is the diagonal stay at five or six feet from the bottom, to allow a birth below for the barrel. Thus the effect of the transverse and oblique

oblique strains of the gib and diagonal stay upon the perpendicular, is increased by their distances from the gudgeons, or points of resistance, and the perpendicular itself considerably weakened by mortises made where the greatest strength is required. Hence the frequent failure of cranes of the common construction, by the breaking of the perpendiculars in the mortises.

It appears, however, that the various parts of a crane formed of wood, cannot be connected together in any other way than by mortising; and as this method *considerably diminishes the strength of the timber*, I make use of cast-iron mortise pieces. Improvement. Cast-iron mortise pieces.

The perpendicular is formed of two oak planks, each eighteen inches wide, four thick, and sixteen feet long; these, at the top and bottom, are let into cast-iron mortise pieces, which retain the planks ten inches asunder. The barrel for the chain, works between them. The piece at the top contains in the middle a dove-tailed mortise, into which a stock for the gib is fixed; for greater security, an iron bolt goes through the whole; the stock projects two feet from the mortise, and a plank eighteen inches deep, and four thick, is bolted to each side of it to form the gib, the interstice between the planks forming a birth for the top block to slide in. The diagonal stay is of the same dimensions, formed in a similar manner, and connected to the perpendicular, by being let into the lower mortise piece. Method of framing, &c.

In this mode of construction scarcely any part of the timber is cut away; and the strength of the materials, so far from being diminished, is augmented by the cast-iron mortise-pieces, the gib is brought much closer to the upper gudgeon, and the centre lines of the perpendicular and the diagonal stay, crossing each other at the top of the lower one, places the whole strain as near as possible in a line with the gudgeons. The business of the perpendicular becomes in consequence little more than that of a mere prop, and consequently requires no greater strength of materials than the diagonal stay. Advantages of this construction detailed.

The top block is made of cast-iron, and has a groove three inches deep on each side, for the purpose of embracing the planks which form the gib,

Lower gudgeon.

To prevent the inconvenience of the dirt of the floor getting into the brass of the lower gudgeon, and thereby obstructing the revolution of the crane, those parts are reverse to the common way, the gudgeon being fixed in the floor, and the socket part which embraces it is cast in the bottom of the mortise-piece, as is also a channel to convey oil to the gudgeon.

Reference to Mr. Gilbert Gilpin's Crane, Plate III. Fig. 1, 2, 3, 4.

Description of the crane by references to the plate.

Fig. 1, Represents the crane with all its parts complete, ready for work.

A B, The perpendicular, formed of two oaken planks, each eighteen inches wide, four thick, and sixteen feet long, let into cast-iron mortise-pieces C D.

E E, The barrel for the chain which works between the two planks of the perpendicular.

F, The top piece, containing in the middle a dovetailed mortise, into which H, a stock for the gib, is fixed; an iron bolt goes through the whole, for greater security. The stock projects two feet from the mortise, and two planks I, K, eighteen inches deep, and four thick, are bolted one on each side of it, to form the gib, the interstices between these planks forming a birth or space for the top block L to slide in. This block is made of cast iron, and has a groove three inches deep on each side.

M, The diagonal stay is of the same dimensions as the gib, formed in a similar manner, and connected to the perpendicular by being let into the lower mortise-piece D.

N, The handle or winch which turns a small pinion O, fixed on the same axis; this pinion works in the teeth of the wheel P, moving on the same axle as the barrel E, on which the chain R lies in spiral grooves.

S, The block and hook by which the goods are raised.

Fig. 2, Is a side view of the handle N, the pinion O the toothed wheel, and the barrel E placed betwixt the two uprights A B.

Fig.

Fig. 3, Shows upon an enlarged scale part of the barrel E, and some of the chain lying in its proper position in one of the spiral grooves, or channels: it is to be noted that the lower edge of one link lies in the groove, and the next link upon the surface of the barrel, and that by this means the chain is prevented from twisting in winding upon the barrel. Description of the crane by references to the plate.

Fig. 4, Shows a section of part of the barrel E, in order to point out clearly the manner in which one link lies within it, the other link on its outside; it is contrasted by *Fig.* 7, the old method of working chains*.

VII.

Construction of the Anchor and Pallets in Graham's dead beat Escapement. By Mr. J. Bennett.

To Mr. Nicholson.

Sir,

As I have always found the following method of drawing the dead beat escapement for clocks very useful and correct in practice, if you think it deserves a place in your valuable Journal, by inserting it, some assistance will probably be afforded to workmen in that branch of mechanics: and you will oblige

Your's,
J. BENNETT.

Norwich,
6th August, 1806.

Draw the line AB (fig. 4. pl. III.) on which describe the circle B the size of the intended swing wheel: then, according to the number of teeth the pallets are intended to scape over, say, As 60† is to 360, so is double the number in- Construction of the wheel and pallets for Graham's dead beat.

* Certificates of the highest respectability are mentioned in the Transactions, which were sent to the Society in proof of the advantages derived from sixteen months daily work of chains applied in this method.

† The first proportion must always be double the number of teeth in the swing wheel.

tended

Construction of the wheel and pallets for Graham's dead beat.

tended and one more to that proportion; thus, suppose the number intended to scape over was 9, double of which is 18, to which add one, makes 19; then work it thus:

If 60 gives 360 what will 19

19

6,0)684,0

114 which is the exact space taken up by nine teeth and a half, half of which is 57; then on the circle already drawn set off on each side the line A B, from an exact line of chords, 57 degrees; from which points draw lines to the centre of the circle, then on these points where they intersect the circle, erect perpendiculars, and prolong them till they intersect in the line A, and this intersection is the centre of motion for the pallets, from which centre draw the arch C C, through the circle where it is intersected by the lines from the centre, or those points where the 57 degrees fall; the arch thus drawn is the receiving and leaving pads of the pallets, the inclination, or inclined plane of the pallets to form an angle of 60 degrees with the lines drawn from the centre of the wheel to its circumference; thus, from the point (as a centre) where the arch C C that forms the pallets intersect the circle, draw half a circle D of any size; then for the receiving pallet E, set off from the point *f* an arch of 60 degrees, which will fall on the circle at *g*, then from that point, and the intersection of the arch C C with the circle B, draw a line, which gives the inclination of the pallet E; and for the leaving pallet G, make a similar circle, and from the point *h* set off 60 degrees, which will fall on the circle at *m*, and draw a similar line as before, which gives the inclination of the pallet G.

Investigation

VIII.

Investigation of the Principles which shew that it would be much safer to jump from the Back than from the Side of a Carriage when run away with by unruly Horses. In a Letter from J. E. CONANT, *Esq. &c.*

To MR. NICHOLSON.

Great Marlborough Street, Sept. 17.

SIR,

AS so many accidents continually happen from the destructive expedient of leaping from the side of an open carriage while the horses are running away with it, perhaps you may be induced to insert this in the Philosophical Journal, in which I attempt to determine how far it may be safe in such cases to leap from the *back* of the vehicle. I hope it will be found correct, but I submit it with due deference to yourself and others.

It is more adviseable to jump from the back than from the side of a carriage in motion.

In the following calculation, setting aside the resistance of the air, I suppose a young man (for it is a young practice to put an unruly horse to a carriage) able to spring two feet perpendicularly against the force of gravity; but in falling one second, he, in common with all bodies, would acquire a velocity of 32 feet per second, and have fallen through a space of 16 feet; and the spaces described being as the squares of the velocities, a man in falling 2 feet acquires a velocity of 11 feet per second, and this equals the velocity with which he first springs from the ground.

Estimate of the velocity of jumping.

Suppose the carriage is moving at the rate of 12 miles an hour, and a man springs from the back of it at an angle of about 40° from the horizon with a force as above equal to about 11 feet per second; this force estimated horizontally will be about 9 feet per second, and the effort of the air, so far from resisting, will be in favour of the horizontal projection; this 9 feet per second, or 6 miles per hour, deducted from the 12 miles, leaves 6 miles per hour for the actual horizontal velocity of the man after his leap, which the force of the air will somewhat lessen, and this, with the accelerating force of gravity,

A man can jump with an horizontal velocity of six miles an hour, — which deducted from that of the carriage will leave six—

gravity, will carry him downward in the projectile curve, and (whatever may be the height of the vehicle) he will come to the ground with nearly the same force as if he had leaped from it while he was standing still, only that he will fall in an opposite direction, and must take care to throw himself in such a position that he does not fall backwards when he touches the ground.

— in the opposite direction.

From the result of this calculation a person run away with in an open carriage may judge how far this mode of escaping will be preferable as to safety.

If a gig be hung low, the leap will probably be easy.

For instance, if a gig is hung so low as to be an easy leap when standing still, he will probably receive little injury by leaping out of it when it is going at the rate of 15, or perhaps even 16, miles an hour, but not more. If he ventures to jump out at the side, the violence with which he would fall to the ground would be almost double, although the height might not be so great.

J. E. CONANT.

IX.

Memoir on Ultramarine, by Messrs. Desormes and Clement; *read to the Class of Physical and Mathematical Sciences of the Institute, January* 27, 1806 *.

Ultramarine not yet examined.

THE fine blue colour known by the name of ultramarine, has not yet been an object of research to chemists, who have hitherto turned their attention to the lapis lazuli, which may in some sort be considered as its ore, and which has never exhibited itself in a crystalline form, except in a single specimen possessed by Mr. Guyton.

One crystallized specimen of lapis lazuli.

Process of extracting ultramarine.

To extract the ultramarine from its ore, a process is employed, to which art offers nothing analogous, and of the theory of which we are totally ignorant. This process consists in levigating the lapis lazuli, and mixing it well with a melted composition of resin, wax, and linseed oil. When these are thoroughly mixed, the compound is suffered to cool, and then well ground with a pestle,

* Annales de Chimie, Vol. LVII. p. 317.

or

or a roller, in warm water. This water becoming turbid is thrown away, and fresh substituted, which is soon perceived to acquire a fine blue tint. When this is sufficiently loaded with the colouring matter, it is put by to settle, and more water is taken, which likewise assumes a blue colour, but less intense than the former. This is repeated, till the water acquires only a dirty grey hue. From these waters a powder is deposited, which is so much the more beautiful, in proportion as the lapis lazuli was more rich, and according to the order in which the water affording it was employed. The gangue of the ultramarine remains behind in the cement.

We employed in our researches ultramarine of various qualities; but that used in the experiments from which we have deduced the approximate proportions of its constituent principles was of the greatest beauty. Only two or three per cent. of this was obtained from a very fine lapis lazuli; yet still it was not perfectly pure, though it was at least fifteen or twenty times as pure as the stone from which it was taken. The finest ultramarine employed in this analysis. Only 2 or 3 per cent. afforded by fine lazulite.

The following are the results of our labours:

1. The specific gravity of ultramarine is to that of water as 2360 to 1000. Specific gravity.

2. This substance, as afforded by the preceding process, contains oily or resinous matters decomposable by fire: their coal burns completely in contact with air: the ultramarine grows red, and as it cools resumes its former beautiful colour. In this operation it loses a little in quality, and requires levigation to reduce it to the state of finenesss and softness it at first possessed. Action of fire on it.

3. With a more violent fire, perhaps of 1500° of the centigrade thermometer [2532° Fahr.] the ultramarine fuses into a black enamel, if the cement mixed with it have not been completely burnt away; but, if this have been done, into a transparent and almost colourless glass. In this fusion it loses twelve per cent. of its weight. Fused into a black enamel — or colourless glass.

4. Treated in the fire with borax, it readily gives a very transparent glass; and sulphur is evolved, with a little carbonic acid, the quantity of which varies according to the quality of the ultramarine. With borax;

5. Exposed to the action of the galvanic pile, the oxigenating Volta's pile;

genating end completely deprives it of colour, but the hydrogenating extremity occasions no change.

oxigen gas; 6. Oxigen gas changes the colour of ultramarine exposed to a red heat, causing it to assume a dirty green hue, with an augmentation of weight of one per cent., owing probably to the formation of sulphurous acid which adheres to it.

hidrogen gas; 7. Hidrogen gas in the same circumstances changes the colour of ultramarine completely, imparts to it a reddish colour, and takes from it sulphur. There does not appear to be any water formed, but there is a loss of weight somewhat exceeding that of the sulphur.

sulphur; 8. Sulphur in fusion does not rob it of colour, and after being driven off by volatilization, leaves the ultramarine as beautiful as before.

sulphurated hidrogen; 9. Liquid sulphurated hidrogen has no action upon it.

limewater; 10. Of lime-water the same may be said.

water of barytes; 11. Water of barytes, assisted by heat, deprives it of colour, and is afterward found to contain silex and alumine.

mineral acids; 12. The sulphuric, nitric, muriatic, and oxigenated muriatic acids presently deprive ultramarine of its colour. The first three in a concentrated state form with it a very thick jelly, the fourth dissolves it almost entirely.

If the sulphuric and muriatic acids be diluted with water, sulphurated hidrogen is evolved. The action of nitric acid produces nitrous gas and sulphuric acid.

acetous acid; 13. The acetous acid acts upon it in a similar manner, but more weakly.

alcalis; 14. Potash and soda in solution heated with ultramarine diminish its weight, and are found to contain alumine. They do not alter its colour.

pure potash; If pure potash be heated strongly on ultramarine, its colour is destroyed, the result of the fusion is redish, and comports itself nearly as if the ultramarine were an argil, or a stone composed of silex and alumine.

ammonia; 15. Ammonia has no action upon it.

oil. 16. If oil be heated with ultramine, the weight of the latter is diminished after being washed in an alcaline solution.

Difficult of analysis. 17. The analysis of ultramarine appeared to us more difficult

difficult than that of a stone of an analogous composition would be, though it is very readily attacked both by acids and alkalis. The disunion of its principles is not complete till after the most decided action of each of the reagents employed.

The quality of the ultramarine we used, which we cannot consider as perfectly pure, and the variation that must occur in the proportions of its constituent principles, induced us to study their nature rather than their quantities. To the knowledge of each of these principles we devoted a separate portion of ultramarine; and it is from these results united, that we conclude a hundred parts of ultramarine to be composed nearly of — Component parts.

Silex	35	8
Alumine	34	8
Soda	23	2
Sulphur	3	1
Carbonated lime	3	1
	100	0

We always experienced a loss of about five per cent; sometimes more. — Loss.

The carbonated lime we discovered is not essential to the composition of ultramarine, any more than the iron, which we did not meet with in ultramarine of the first quality procured from a lazulite little charged with sulphurated iron. It is not the same with sulphur, which always occurs. — Carbonate of lime. Sulphur.

The following is the mode in which we ascertained the nature of the four substances, that appear to us essential to ultramarine. — Processes of analyzation.

Thirty grammes [an ounce] of fine ultramine, heated with sulphuric acid, left a residuum weighing 14 grammes. The liquor on evaporation exhibited a few crystals of alum*, and a great deal of sulphate of soda in long needles. — Alumine and soda.

* It is probable that the alcali, which occasioned the crystallization of this sulphate of alumine, was potash proceeding from the ultramarine: we do not affirm this, however, because we had not secured the salt from the ammoniacal vapours, that might have existed in the laboratory.

All these crystals and the remaining liquor afforded by means of ammonia 6·85 of dry alumine, and 9·60 of sulphate of soda fused by fire.

These more than the sulphuric acid indicated.

We found by other experiments, that the alumine and soda were commonly in greater quantity than the action of sulphuric acid indicated.

Silex.

By passing oxigenated muriatic acid gas into water in which 20 grammes of ultramarine were kept in constant agitation, 18·48 were dissolved. The remaining 1·52 had all the characters of silex. From the solution we obtained 4·6 of dry alumine, as much muriate of soda as contained about 4 grammes of alkali, and a portion of sulphate of barytes containing 6 tenths of a gramme of sulphur, supposing it to be composed of 33 per cent. of sulphuric acid, and this acid of 52 per cent. of sulphur. The quantity of silex was not well ascertained.

If 5 grammes of ultramarine be fused with 20 grammes of potash, and the compound be treated with alcohol, its weight is diminished one gramme, and the alcohol contains very little silex and alumine. This loss is evidently owing to the soda of the ultramarine, which quits the other principles, because their combination has been broken by the action of the potash in the fire.

Mixture of some foreign substance suspected

On treating ultramarine with carbonated soda, we obtained from 10 grammes 3·3 of silex, possessing all its peculiar characters in a manner less equivocal than was sometimes the case, when it had been procured from ultramarine treated by acids or caustic alkalis. We had supposed, that this was owing to a mixture of some foreign substance, but we were unable to detect any. To ascertain this silex we had employed the ordinary means; and among the rest volatilization by the fluoric acid, which deposited a jelly in the water it was passed through.

Results.

Thus the ultramarine afforded on decomposition silex, alumine, soda, and sulphur.

Theory of the process of extraction.

If we bear in mind, that this valuable substance, as furnished by the process of its extraction, contains oleaginous particles; that soda is one of its constituent principles; that the first waters used for washing away the ultramarine from the cement, with which its ore had been

incorporated, are soft to the touch like an alkaline lixivium; and that they leave an alcaline residuum on evaporation; it will be easy to deduce the following theory.

Theory of ultramarine.

The cement with which the lapis lazuli is mixed is intended to impart oil to the ultramarine, to form a kind of soap, which the warm water carries away, rendering it a little soluble; while the gangue remains united to the cement, in the midst of which it is far from being so easily wetted as the ultramarine, because of its want of soda; in consequence of which it cannot slip like the ultramarine from the fatty, resinous substance, that forms a kind of net for it. In short the process of extraction of ultramarine is a real *saponation* [*savonnage*]; an expression in which we hope we may be indulged on account of its fitness.

These are the conclusions, that we think may be drawn from our labours, without being too bold. May this first attempt on a substance so little known and so singular be followed by its artificial production.

X.

Abstract of a Memoir on Human Hair; read at the National Institute on the 3rd of March, by M.* Vauquelin †.

Object of inquiry; the substance of hair.

THE principal objects the author proposed to himself was, to investigate the nature of the animal matter of which hairs are formed, and to ascertain whether there were any thing analogous to it in the animal economy. In the course of his experiments, however, phenomena presented themselves, which, appearing foreign to the principal substance, led him farther than he had intended. It did not originally enter into his plan, to inquire whence the various colours of hair are derived, yet on this subject his attention was most employed. It is only, observes Mr. Vauquelin, by attending a long time to the

Led by the phenomena to examine the colouring matter.

* Annales de Chimie, Vol. LVIII. p. 41.

† Messrs. Chevreuil and Caballe, two of Mr. Vauquelin's pupils, assisted him in making the experiments recorded in this Memoir.

same

same object, carefully observing the phenomena that occur, and meditating on the causes that have produced them, that we arrive at results, which it was impossible to have foreseen *a priori.* He does not flatter himself, however, that he has penetrated all the secrets of Nature in this respect, and he offers his ideas with that diffidence which we ought to feel in researches of such difficulty. But he gives an accurate description of his experiments: he compares them, discusses them, and draws from them these conclusions, that appear to him most natural. Of the principal of these experiments, and the corollaries he deduces from them, we shall give a concise account.

Hair boiled long in water

I boiled hairs in water for several days, says Mr. Vauquelin, without being able to dissolve them; yet the water contained a small quantity of animal matter, as was demonstrated by nut-galls and other reagents.

is not dissolved

It is probable, that this matter, which imparts to water the property of becoming putrid, is foreign to the substance of the hair itself. From this experiment I infer, that at the temperature to which water can be raised under the pressure of the atmosphere alone, hair is not soluble in it.

Dissolved in a close vessel,

but decomposed in too strong a heat.

I effected their solution, however, without any alteration in Papin's digester, by regulating the degree of heat. In this operation, if the heat be carried beyond a certain point, the hair will be wholly or partly decomposed; as is shewn by the ammonia, carbonic acid, and empyreumatic fetid oil, which is found in the solution, to which the oil imparts a deep yellow colour.

Sulphurated hidrogen evolved,

perhaps formed during the process.

In either case a large quantity of sulphurated hidrogen gas is evolved, which acts strongly on the sides of the copper vessel, turning them black. More is found if the heat be raised to a higher degree, which seems to indicate, that this matter is produced during the operation.

Black hair affords a black residuum;

If the hair employed were black, or if the heat were not sufficiently high to decompose the hair, a black matter remains, which falls down very slowly, in consequence of its minute division and the consistence of the solution. This substance is composed chiefly of a black oil, as thick as a bitumen, a little soluble either in alcohol or alcalis, with iron and sulphur perhaps united together.

Red

Red hair leaves a yellowish red residuum, in which are found a great deal of oil, sulphur, and a little iron. red hair a red.

The solutions, when they have been filtered, have scarcely any colour: concentrated acids render them turbid; but an excess of these reagents restore their former transparency, and weak acids produce no change in them. The infusion of galls and oxigenated muriatic acid form in them copious precipitates. Silver is blackened in them, and the acetate of lead is precipitated brown. These solutions, evaporated with all due precaution, did not assume the consistence of jelly on cooling, but remained glutinous; whence I concluded, that the substance of hair is not of a gelatinous nature. Action of reagents on the solution.

The acids form more copious and deeper coloured precipitates in the solutions of hair effected at a higher temperature, in consequence of their decomposing an ammoniacal soap, which does not take place in the former case.

I have likewise dissolved hair, both black and red, in water containing merely 4 per cent. of caustic potash. During this solution hidrosulphure of ammonia is evolved, which seems to announce an incipient decomposition of the black hair, leaving a black residuum composed of a thick oil, still a little animalized, with iron and sulphur. After the solution of the red hair, a yellow oil containing sulphur and a few atoms of iron remains. Solution in weak lixivium.

In these solutions acids form white precipitates, soluble in an excess of the acids. When these precipitates are thus redissolved in acids, at the expiration of a certain time an oil appears on the surface in the form of a pellicle with the prismatic colours. Action of acids on it.

The solution of hair in potash precipitates lead of a black hue on account of the hidrosulphuret it contains. That of the red hair appears to contain most. When it has been freed from sulphur by exposure to the air, it has only a smell of soapsuds, like which it becomes mouldy. Of lead.

Each of the acids acts in a particular manner on hair. The sulphuric and muriatic acids assume at first a fine rose colour, and afterward dissolve the hair. The nitric acid turns hair yellow, and likewise dissolves it by means of Effects of the different acids.

of a gentle heat. The solution exhibits on its surface a black oil, if the hair were of that colour, and a red oil if the hair were red. Both these oils ultimately grow white, and become concrete on cooling.

Yield oxalis acid, bitter substance, iron, and sulphur.

This same solution, properly evaporated, affords much oxalic acid; and the uncrystallizable mother water contains the bitter substance, a great deal of iron, and sulphuric acid arising from the sulphur of the hair.

In red hair less iron, more sulphur.

The solution of red hair in nitric acid contains less iron, but more sulphuric acid, than that of black hair.

Oxigenated muriatic acid gas.

Oxigenated muriatic acid gas at first whitens hair, soon after softens it, and reduces it to the form of a viscous and transparent paste like turpentine. This is bitter and partly soluble in water, partly in alcohol.

Destructive distillation.

From hair subjected to the action of fire in a close apparatus I have obtained the same products as from any other animal substance, with this difference, that it furnishes more sulphur, and gives out very little gas. It leaves in the retort twenty-eight or thirty hundredth part of coal.

Incineration.

By incineration they yielded iron and manganese, which impart a brown yellow colour to the ashes; phosphate, sulphate, and carbonate of lime; a little muriate of soda; and a considerable portion of silex. The ashes of red hair are less coloured, because they contain less iron and manganese; those of white hair likewise contain less, but we find in them a great deal of magnesia, at least a great deal with respect to the other principles, for hair scarcely yields above ·015 of ashes.

Alcohol extracts two oils from black hair;—

Alcohol extracts from black hair two kinds of oil: the one white, which on cooling subsides in the form of little shining scales, the other, which separates as the alcohol evaporates, is of a greyish green hue, and ultimately becomes concrete also.

and from red but different.

Red hair likewise affords a white concrete oil like spermaceti, but the alcohol on evaporation lets fall another oil as red as blood. What is remarkable and interesting in this experiment is, that the reddest hair subjected to it becomes of a deep brown or chesnut colour; whence I conclude, that the colour of red hair is owing to the presence of this oil.

From

From the experiments related in the Memoir of Mr. Vauquelin, a great number of which, being merely accessory to the principal object, we have omitted, it appears, that black hair is formed of nine different substances, namely:

Constituent parts of black hair.

1 An animal matter, which constitutes the greater part;

2. A white concrete oil in small quantity:

3. Another oil of a greyish green colour, more abundant than the former;

4. Iron, the state of which in the hair is uncertain;

5. A few particles of oxide of manganese;

6. Phosphate of lime;

7. Carbonate of lime in very small quantity;

8. Silex, in a conspicuous quantity;

9. Lastly, a considerable quantity of sulphur.

Difference of red hair, and of white.

The same experiments shew, that red hair differs from black only in containing a red oil instead of a blackish green oil: and that white hair differs from both these only in the oil being nearly colourless, and in containing phosphate of magnesia, which is not found in them.

Causes of the difference of colour in hair.

From this knowledge of the nature of the constituent principles of hair Mr. Vauquelin thinks we may account for the various colours that distinguish it. According to him the black colour will be owing to a black and as it were bituminous oil, and perhaps likewise to a combination of sulphur with iron. Carotty and flaxen hair will be occasioned by the presence of a red or yellow oil, which when deepest, and mixed with a small quantity of brown oil, produces the dark red hair. Lastly, white hair is owing to the absence of the black oil and sulphurated iron. He believes, that in the carrotty and flaxen, as well as in the white, there is always an excess of sulphur; since, on the application of white metallic oxides to them, such as those of mercury, lead, bismuth, &c., they grow black very speedily. The manner in which this substance acts on metallic bodies leads him to suspect, that it is combined with hidrogen.

Blackened by metallic oxides.

Wh'teness suddenly produced

Mr. Vauquelin attempts next to explain the whiteness produced suddenly in the hair of persons struck with profound grief or great terror. To explain this, he says, we

we must suppose, that in these critical moments, when nature undergoes a revolution, and the natural functions are in consequence suspended or changed, some agent is developed in the animal economy, which, passing into the hair, decomposes the colouring matter. But what agent can produce this effect? The acids alone appear capable of it: at least this is certain, black hair immersed some time in them, particularly in the oxigenated muriatic acid, whitens very evidently.

owing to an acid.

Arguments in defence of this opinion.

The rapid production of an acid in the animal economy does not appear to him impossible, considering that a fit of anger in men, as well as in inferior animals, is sufficient to change the nature of certain of their fluids, and render them venomous; and seeing that the galvanic fluid frequently occasions the formation of an acid or an alkali, according to circumstances, both in animal and vegetable substances. As to the whiteness produced gradually by age, he ascribes this to a deficient secretion of colouring matter.

Whiteness from age.

Properties owing to the colouring matter.

In hair, exclusive of the animal matter that forms its basis, and which is the same in all, there is a colouring matter, that may be separated from it, and the hue of which varies according to the kind of hair of which it constitutes the distinction. To this fatty substance Mr. Vauquelin attributes the suppleness, elasticity, and unalterability, which exist in hair: to this substance too is owing no doubt the property it has of burning so rapidly, and that of forming soap abundantly with alkalis.

Its animal substance

After having treated of the colouring matters of hair, he endeavours to characterise the animal matter, that forms its substance, by comparing it with all those of which we have any knowledge. Without relating all the experiments he has made in this respect, we shall observe, that it is not gelatine, since its solution in water, which is difficult to effect, never becomes a jelly on evaporation; neither is it albumen, for this would not dissolve in boiling water without being decomposed, and its solution would be differently affected by reagents.

is neither gelatine,

nor albumen;

but mucus, or something similar to it.

The humour to which the substance of hair approaches nearest, if it be not absolutely the same, is, according to Mr. Vauquelin, that which physiologists have designated

by

by the name of *mucus*, or animal mucilage, which is neither gelatine nor albumen.

Mucus.

This humour which is secreted in the nostrils, mouth, œsophagus, trachea, stomach, bladder, and all the cavities of the body in general, imparts to water considerable viscosity, and the property of frothing greatly on agitation. In certain species of coryza it may be drawn out into threads like the substance of silk or the web of the spider; retains its transparency and flexibility after desication; and Mr. Vauquelin has no doubt, that it would perfectly resemble hair, if it contained a little oil.

In some diseased states approaches to hair.

Other parts formed from it.

The epidermis, nails, horns, wool, and hair of beasts in general, are formed of the same animal mucus, and equally include in their composition a certain quantity of oil, which imparts to them the suppleness and elasticity they are known to possess.

Humour of the plica, a superfluous secretion of the matter of hair.

Mr. Vauquelin has begun an examination of the humour of the *plica polonica*, with which he was furnished by Mr. Alibert, physician to St. Lewis's Hospital; and from what he has done, he is led to believe, that it is of the same nature as the substance of the hair, but secreted in greater quantity than the formation of the hair requires.

XI.

Abstract of a Memoir on a new Principle in Meteoric Stones: by A. Laugier.*

Composition of meteoric stones

EVER since the English chemist Mr. Howard, called the attention of philosophers and naturalists towards the stones called meteoric, all chemists who have repeated the experiments laid down in his interesting memoir, have obtained similar results. They all agree that whatever the time, or wherever the place in which these stones have fallen, their component principles have been the same, viz. silex, iron, manganese, sulphur, nickel, with a few accidental traces of lime and alumine. We see, in comparing the results of their analysis, that these principles exist in very nearly equal proportions. M. Proust has lately

* Annales de Chimie, Vol. LVIII p. 261.—June 1806.

announced

announced the existence of manganese in the meteoric stones analyzed by him, which fact is confirmed by those chemists who have since bestowed their attention on this subject.

They contain chrome.

M. Laugier, professor in the pharmaceutical school of Paris, assistant naturalist and operator of analysis to the Museum of Natural History, in analysing a meteoric stone which fell at Verona in 1663, has discovered a principle hitherto unobserved in stones of this kind. This principle is *chrome*, and is the subject of the present memoir.

The author discovered it by using alkali as his first agent.

"It is very probable," says the author, "that I should have overlooked the presence of Chrome, had I not deviated from the method of analysis usually adopted. Acids have always been made use of, which are perhaps the most natural and commodious agents; but in this case I employed caustic alkali, which has the advantage of indicating the presence of chrome, however small may be its quantity, whilst it remains almost imperceptible when held in solution by acids, particularly if blended with any quantity of iron, manganese, &c."

Process. Solution in caustic alkali; washing supersat. with nitric acid. Precipitation of the chrome by nitrate of mercury.

The following is the author's mode of separating the chrome, and of determining its proportion: He dissolved one part of the stone in three parts of caustic alkali, and washed the mass with distilled water, which received a yellow colour, or a greenish-yellow from the manganese: on leaving the mixture to settle, the manganese fell to the bottom, and the liquor regained its pure yellow colour. The solution was then re-mixed with the washing, and after being sufficiently diluted with water, to prevent the precipitation of the silex, super-saturated with a slight excess of nitric acid. Recently prepared nitrate of mercury, at the minimum, was poured into this solution, which immediately threw down a red orange-coloured precipitate, or chromate of mercury; this was suffered to remain till the next day to subside, when the supernatant liquor was decanted, and the precipitate washed in several waters, until deprived of all taste; it was then thrown into a platina crucible, the water evaporated, and the chromate of mercury by desication decomposed into green oxide of chrome, whose quantity amounted to about a *hundredth* part

part of the weight of the stone operated upon. This green residuum presents all the qualities of oxide of chrome.

As the stone of Verona is similar in all its physical properties to other meteoric stones, the author of this memoir wished to ascertain if others also contained the chrome found in that of Verona. He accordingly examined fragments of the stones which fell at Ensisheim, at l'Aigle, at Barbotain, near Bordeaux, and recently near Apt; in each of these four stones he discovered the presence of chrome. It is remarkable that the stone of Verona, wherein he first observed this metal, is of all the five, that which contains the least, its portion being only half a centenary, whereas the others contain a full centenary. Other stones of this kind contain chrome.

The author draws from his memoir the following conclusions, in which he is fully countenanced by M. Vauquelin. General conclusions.

1. That the five meteoric stones of Verona, Barbotain, Ensisheim, Aigle and Apt, contain, besides those principles already known to chemists, the metal called *chrome*, in the proportion of about one hundredth part.

2. That it is very probable that all meteoric stones possess this principle; since they all resemble each other in their physical and chemical characters, and have all, so far as has been hitherto ascertained, the same origin.

3. That in many cases, in order to attain the requisite precision of chemical analysis, it may perhaps be expedient to treat the same substance with both acids and alkalis; as experience demonstrates that parinciple may be overlooked in one case, which will be obvious in the other.

XII.

Account of the dreadful Fall of the Summit and Part of Mount Rosenberg, which happened on the 2nd of last Month.

Bern, Sept. 7.

INFORMATION has lately been received of a dreadful accident which has destroyed several villages in the canton of Schwitz, situate between the lakes of Zug and

and Lauwertz. M. M. Freudenreich and Schlatter, directors of the mines, set out yesterday evening, by order of Government, to give aid. The following are the details of this disaster, the most dreadful recorded in the annals of Switzerland :

Sudden fall of the summit of mount Rosenberg, overwhelming five villages and partly filling a lake.

" On Tuesday, the 2d of September, at five in the evening, the Knippenbuhl Rock, which formed the summit of Mount Rosenberg, was on a sudden detached from its station, and at the same time part of the mountain, of several feet in thickness, on the western side, and about 280 feet in thickness on the east side, gave way, and fell into the valley which separates the lake of Zug from that of Lauwertz, overwhelming the whole of the villages of Goldau, Rœthan, Busingen, Huzloch, three parts of that of Lauwertz, and some houses in the village of Stein. The fall of one part of the mountain into the lake of Lauwertz, about a fourth part of which is filled up, caused such an agitation in the waters of the lake, that they overthrew a number of houses, chapels, mills, &c. along the southern shore of the lake; amongst others, the mill of Lauwertz where fifteen persons were killed and buried in the ruins of the buildings, all the parts of which were dispersed with such violence, that the foundation only remains. This mill was situated 50 or 60 feet above the level of the lake.

Sufferers.

" The waves also beat against the village of Seeven, situate at the extremity of the lake, and destroyed some houses. Two persons were killed.—In the villages which were overwhelmed, not an individual escaped. Upwards of 1,000 persons have been victims of this disaster. A society of travellers, thirteen in number, were on the road from Arth to Schwitz: nine, who walked first, perished; the other four, who were about forty paces distant, escaped. Those who were killed, were, M. M. Rodolph Jenner, of Brestenberg; Colonel Victor Steigner, of Berne; Charles May, of Ruth; Doctor Ludwig, of Arbon, in Thurgovia; Mademoiselle Diesbach, of Berthoud; Madame Diesbach, of Watteville; Madame Frankhauser, of Berthoud; and two guides, of Arth. Five minutes sufficed to complete this disaster.

The effects ex-

" At Schwitz, some persons heard the noise, and saw at

at a distance the vapour which covered the place where the accident happened, and which was carried towards Zug, on the opposite side, with a strong sulphureous smell. The falling of the mountain extended from the summit to the opposite side, beyound the Lake, a distance of three leagues from north to south, and a league and a quarter from west to east. There is nothing now to be seen but melancholy ruins, through the whole of that country, which presented the richest communes in the canton of Schwitz, inhabited by a brave and faithful people. Only thirty persons remain out of this interesting population.

tended three leagues. Sulphureous smell

" Several circumstances attending this event are very remarkable. Enormous masses of rock were carried through the air to prodigious distances. The rocks in falling, drew with them immense masses of earth, of from ten to eighty feet in thickness; and numbers of these masses, together with large blocks of flint stone, were thrown on the opposite shore, to the height of from eighty to one hundred feet. One can scarcely believe ones eyes when one seas these *phenomena*. Every instant one sees houses, some forced on one side, others cut in two, and separated at great distances; and others carried more than a quarter of a league from their foundations.

Masses of rocks projected; or rebounding.

" The Lake of Lauwertz has lost about a quarter of its extent, but its recovered part is filled at present by the waters of several brooks, which no longer flow. That rich plain, which was so beautiful, now presents a mountain of near 100 feet in height, of a league and a half in length, and as much in breadth.

Effect on the lake.

" Mount Rosenberg bears E. N. E. from Arth. It is its western part which has fallen down; that which was on the side of Arth, after descending direct towards its base, was suddenly thrown to the east, and thus Arth, Zug, and all that side of the Lake were saved. The thickness of the mass carried down, appeared to be two feet on the western side, and upwards of 150 on the east side. The Knippenbuhl seemed to have announced this misfortune so early as the year 1774, when it detached itself from the mass of the mountain. The Isle of Schwanau, elevated on a rock, in the middle of the Lake experienced also some damage, particularly its church. The

Account of the mountain.

The good Hermit was fortunately at Ensiddlen. The long road of the Lake is broken in a thousand places.

Farther particulars.

"Succours have been sent with the greatest promptitude. Six hundred workmen from Zug and Schwitz have gone to the banks of the Lake of Lauwertz, particularly the mouth of the Seven. This small river was so obstructed by ruins of all descriptions, wood, trees, houses, &c. that, without prompt assistance, the safety of all the houses below Schwitz to Brunnen, would have been menaced.

"One man had the good fortune to withdraw in time under ground, with his servant and a child, which he held in his arms. In one house near Arth is still living, a poor man, who had both his thighs broken. During the search which has already been made, twenty persons were discovered dead at the entrance of the village of Goldau, men, women, and children, some having their arms, others their heads, others their legs separated from their bodies, and the bodies of some cut in half. We have coasted along the foot of Riga, where the greatest part of those who survived this catastrophe took refuge: alas! not more than thirty. An old man whom we met, said to us, "I had sons, daughters, and a great number of grand children. I had a wife and other relations. I alone remain." A little girl said, "I have no longer father or mother, brothers or sisters." A woman had lost her mother, husband, brothers, sisters, and five children.

"The villages of Goldau and Rothen, consisting of 115 houses, that of Busingen, of 126, and that of Huzloch, have totally disappeared. Of Lauwertz, which lost 25 houses, there remains ten buildings, all much damaged. Stein has lost two houses and several stables, which were in great numbers in all these villages.

"P. S. Twenty years since, General Psyffer predicted this catastrophe, from the knowledge which he had of the mountain. A professor of Schwitz said, that above Spietzflue was a sea of water, which had undermined the rock for several years, and that below there was a cavern of great depth, where the waters were engulphed. The quantity of water which has fallen during the preceding years, has hastened this catastrophe, and the rains of some weeks past have decided."

XIII.

Farther Remarks and Experiments on Vision under Water. In a second Letter from a Correspondent: with some Observations in Reply. By the Editor.

London Institution, Sept. 17, 1806.

To Mr. Nicholson.

Sir,

I HAVE to thank you, (before I make any further remarks on the Paper in your 58th number, "On the Art of Swimming,") for the insertion of my letter in your 60th Journal, and for the candid manner in which you were willing to investigate, whether my objection to what you therein stated was founded on fact. Introduction.

I have in consequence of your reply been induced to make some actual experiments, since I had the pleasure of reading the account of those, which, together with your two friends you had made. I will presently state them to you, and they will, I think, clear your mind of every doubt that can be entertained on the subject; permit me however first to revert to the Paper in which you differ in opinion with Dr. Franklin—your words are these, "I am rather surprised at the Doctor's direction about the egg, and the eyes open under water, because it seems as if he thought the submerged experimentalist could see the egg." You after that say you must refuse your credit to such assertions, and add that "Experiment will easily clear up the matter to those who know nothing of optics." You then state your unsuccessful attempt to pick up your buckle in five feet water at Joanna, your experiment at Harlem follows, and your conclusion is thus drawn in your own words. "Whence it appears, that all the stories of wonderful divers who could descend into the sea and bring up small objects, such as jewels and trinkets must be considered as fabulous." In the first writing of W. N. he treated the subject as if it were impossible to see under water.

On your reply to my letter, I have to remark, that the cylindrical glass vessel, with which you made your ex- Objections to the Experiments of W. N.

periments

periments is almost as objectionable as the washing tub, or wash-hand bason. I would ask if the very form of your glass vessel might not have the effects of refracting the rays of light, or of their crossing so as to cause an imperfect vision of the object looked at? You of course know that in our Courts of Judicature, the evidence of a person swearing to a transaction seen through blown glass is not held admissible; and here I do not see, what occasion there is, in making the experiment, that the rays of light should pass through any other medium but the water itself. Now with respect to the distance, the focus was obtained under water, it appears to me not to be the question, but whether the object was visible or not. It so happens I am short sighted, but it surely cannot be contended that I cannot see, because I hold a newspaper nearer my eye than another, as the eyes of different people of the same age are of different focus, but they still see, perhaps equally well at their respective foci. Age also will cause a difference. I have no doubt that convex lenses would enable the eye to see clearer at a greater distance in water, for we know the crystalline humour in fish is almost globular, and doubtless for that purpose.

In your "conclusion that the human eye cannot distinguish objects under water," I think you begin to discover that your former opinion *may* be fallacious, as you are disposed to question whether some people may not see *imperfectly* under water, and conclude thus; "but I must confess that I do not incline to that opinion."

New experiments, in the Thames. A diver brought up various objects from a depth of near nine feet.

The experiments I made are these: I went on the Thames in a boat a little above Richmond, accompanied by two friends; we took with us a native of Africa who was to make the experiment before us; we took in the boat two eggs, thinking them the most proper for trial, from what you had stated in the 4th paragraph of your reply; one of which I had spotted with red sealing wax. I first threw the spotted egg into water, between eight and nine feet deep, where the water was not very clear; for we could not see the egg at the bottom from the boat: our diver on the first attempt readily brought us up the egg. I then threw in both, desiring him to bring up the plain one only, which as readily he did, though he saw the

the spotted one at the bottom close to it. I afterwards threw in the white and a piece of painted wood, 4 inches long, prepared for the purpose, with lead in it to sink it. He then brought up the egg in one hand and the wood in the other. Being perfectly satisfied with these experiments, and the wind being at North East, we did not desire our diver to repeat them.

—and probably would have succeeded in all his attempts.

For my own part, I confess, I should not like to contract with our African friend to throw in as many guineas separately, as he would separately pick up in the same depth of water, provided the bottom was free from weeds and mud, though he were to give me two for each he missed finding.

Proposal to repeat these experiments.

Perhaps the relation of these facts may strike your mind less forcibly,

> Quàm quæ sunt oculis subjecta fidelibus, et quæ
> Ipse sibi tradit spectator.

If so I shall be very happy to have these on any other experiments, more convincing if possible, exhibited before you and your friends whenever you may please to appoint.

Narratives of divers.

I could cite many accounts of the pearl fisheries from respectable authors; and the fact of divers bringing up the particular shell fish, that produce the pearls, I think stands upon incontrovertible evidence, though you have, misled by a false hypothesis, treated these accounts as fabulous.

Conclusion.

I am well convinced, Sir, from your known character, that if you find you have been mistaken in what you have asserted, you will be most ready to allow it, thereby verifying what Solomon long since has said. "Give opportunity to a wise man and he will yet be wiser."

I am,

Sir,

With the greatest respect,

Your most obedient servant,

A DIVER.

Reply. W. N.

Question whether W. N. or his correspondent have reasoned correctly from their facts.

After expressing my satisfaction that the present subject of enquiry has been treated by an immediate reference to facts, I will take the liberty to make a few remarks, chiefly with a view to indicate what conclusions we ought to deduce from them.

W. N. because he cannot himself see under water, has concluded that no one can. *The diver* has made the opposite conclusion from facts also limited to some men only.

I admit that every remark I made upon Dr. Franklin's assumption, that men can see under water, was founded upon my own experience, that the contrary position, with regard to myself, is true; and my error appears to have been of the same nature as that of my able oponent.—I, by making a general inference from particular facts, have concluded that *no man can see or distinguish under water*;—he, on the contrary, making too extended a deduction from his own observations, has concluded that I have been misled by a false hypothesis, and seems to think that *all men can see under water.*

I think the present controversy has given us both sufficient reason, to enquire whether, among men who can see objects in the air at all distances, with considerable distinctness, there be not many who like myself, cannot distinguish at all under water; and many others, who like my correspondent, can see almost as distinctly in that element as they do out of it. At all events the former cannot be a question of any doubt to those who find they do not distinguish (or see) under water.

Vindication of the use of the glass vessel.

It does not seem to me necessary to enter upon any discussion respecting my cylindrical glass, because my experiment appears to have been misapprehended. There was nothing but water between the eyes and the objects, and yet we could not distinguish them. The vessel being glass, the objects were well enlightened; in effecting which the figure of the glass was of no consequence, as we did not look through it. The experiment of the lens neither confirms nor weakens the truth of the general fact.

Whether the eye can alter its figure so as to see in air at two inches distance. Probably not. --But this seems

When I was a young man, I saw objects distinctly at four inches distance. At present I see imperfectly at less distances than twelve inches, though I am still near-sighted with regard to objects more remote than four feet. As the curvature and refractive density of the human cornea

nea may differ in different subjects, and have not, that I know of, been well determined, I shall not attempt to treat this inquiry on the strict principles of optics; but only observe that I was then able to do by adjustment of the organ, what would now require the assistance of a four inch lens; and that I do not apprehend that I could then, or that any one else can, see distinctly in the air at two inches distance. But this appears necessary to be done by an eye like mine in order to see under water.

wanting for distinct vision under water.

A certain part of the refraction performed by the eye is effected by the anterior surface of the cornea, and the rest by the internal structure. Two eyes may be so constructed, as that in one of them the cornea may perform a very considerable part, and in the other, the greater part may be effected by the internal structure; and both these eyes may see equally well: but they would not both be alike affected by immersion in water. That with the most prominent cornea would afford the least distinctness; the other might be so little affected as to give distinct vision under water, by a change within the reach of its ordinary adjustment. Do the curvatures of the cornea in different subjects, who see well, vary sufficiently to admit of this solution of our difficulty?—This must be referred to experiment.

The flatter the cornea the less would an eye be affected by immersion in water.

Are human eyes so various?

My correspondent has offered to exhibit his experiments before me. I shall be happy to accept his kindness, and at the same time should be glad if his African friend would look into my large jar.

Offers to repeat the experiments.

XIV.

Experiments and Observations on the Adhesion of the Particles of Water to each other. By BENJAMIN, *Count of Rumford, F. R. S. &c. Communicated by the Author to the National Institution of France, and transmitted to him by the Editor.*

(Continued from page 56.)

If the particles of water adhere strongly to each other, it appears to me to be a necessary consequence that a kind of pellicle will be formed at the surface of the liquid, and even at all these surfaces, whatever may be in other

The film is considered as the consequence of the adhesion of the aqueous particles.

other respects the mobility of these particles, or rather of the small liquid masses composed of a great number of them, when they are remote from the surface and possess their fluidity without impediment.

Film at the lower surface of the water.

When a small solid body, placed on the surface of water becomes wetted, it immediately descends beneath the pellicle, which no longer opposes its subsistence. At this period the viscidity of the water begins to manifest itself in a very different manner, but with infinitely less effect than when it acts at the confines of the liquid. But it is not yet time to enquire into this part of our subject.

Water was poured on mercury and ether upon the water.

With a view to render sensible the resistance which the pellicle of the inferior surface of a stratum of water opposes to a solid body which passes through that stratum by falling freely downwards, I made the following experiment.

EXPERIMENT VI.

The lower surface of the water next the mercury supported a larger globule than the upper could have done.

Having filled a small wine glass to about half its height, with very pure mercury, I poured a stratum of water of three lines in thickness upon the mercury, and upon that a stratum of ether of two lines.

When the whole was at rest, I took with the small tool before described a spherule of mercury of about one third of a line in diameter, and let it fall through the stratum of ether.

This spherule being too heavy to be supported by the pellicle at the superior surface of the water broke it, and descended through that fluid; but upon its arrival at the inferior surface it was stopped, and remained there preserving its spherical form.

I moved this spherule with the extremity of a feather, and even compressed it; but it always preserved its form without mixing with the mass of mercury on which it appeared to rest.

The lower surface of gum water supported a still larger globule.

It was no doubt the pellicle of the inferior surface of the stratum of water which prevented this contact, and as this pellicle was supported by the mercury on which it rested, I was not at all surprised to find that it could support without being broken, a spherule of mercury much larger than the pellicle of the superior surface could support.

In order to satisfy myself that the viscidity of the water was

was the cause of the suspension of this mercurial globule at the bottom of that fluid I repeated the experiments and varied it by substituting water, containing a certain quantity of gum arabic, in solution, in the place of pure water; and I found in fact that much larger spherules were supported when the viscidity of the water was thus augmented.

[To be concluded.]

XV.

*Observations on some Errors contained in Mr. Thomas Reid's Paper, published in the Journal of the last Month. From a Correspondent *.*

Introduction.

As Mr. Reid's paper inserted in the last Number of Mr. Nicholson's Journal, contains some statements which materially affect the history of chronometry, but which, on referring to the original documents appear to be very incorrect, it seems proper not to lose time in rectifying errors which otherwise might mislead such persons as have no opportunity or leisure to investigate the matter in question.

The invention of the detached escapement belongs to P. le Roy.

The invention of the detached escapement is one of the points the most satisfactorily ascertained in the progress of time-piece making. It is clearly due to P. le Roy, who first produced an escapement of that sort, and presented it in 1748 to the Academy of Sciences at Paris; and his claim has never yet been disputed with any degree of reason, though considerable discussions have arisen respecting the pretensions of other artists who since the above date have thought proper to aspire to a share in the same honour. The subject has been canvassed on several occasions, during the long interval of time which has elapsed since that epoch; and every thing that could be said upon it seemed exhausted, till the present moment, when Mr. Reid, in a postscript to his paper, tells us, that Mr. Thiout in 1741 † published the description of a

Mr. Reid asserts that Thiout invented it before.

* Viz. the author of the Memoir at page 273 of our last Vol.

† The title of Thiout's work is, "Traité de l'Horlogerie méchanique et pratique, approuvée par l'Academie Royale des Sciences." 2 vol. 4to.

2 detached

detached escapement, which, if it were really such, would of course be the first model of that idea ever communicated to the world, and would consequently degrade Le Roy from the rank of an inventor to that of a mere copyist or imitator. The real state of the case, however, is as follows:—The Academy of Sciences in 1748 received the escapement of Le Roy as new, though Thiout's book was published only a few years before; and no opposition was made to this declaration by the author, (whom we believe to have been then alive,) or by any of his friends and successors. One of the committee who examined that invention was Mr. le Camus, a good judge of watch-making, who, as such, came, afterwards, with Mr. Berthoud, to this country, by order of the French Government, in order to witness the disclosure of the principle of Mr. Harrison's time-keeper; and the same Mr. le Camus, who first mentioned that Dutertre the elder had conceived the idea of a detached escapement, according to a construction which was preserved in his family, never said any thing respecting the invention of Thiout, although that invention was described in a work generally known. Nay, the Academy of Sciences continued so miserably blind, that when, some years after, Mr. Platier submitted to that body a new detent escapement, their committee declared, that P. le Roy was the first who had thought of this sort of escapement*. The same ignorance, or wilful error, has, since that time, attended not only the philosophers who have candidly endeavoured to investigate these matters, but also the critics and rivals who may have maliciously searched for circumstances likely to humiliate the pride of the different competitors who have pretended to the credit of originality in the construction of the free escapement. This we cannot but observe seems an extraordinary case. The truth however is, as may be easily guessed from the preceding statement, that the representation of the escapement, as published by Mr. Reid, is totally different from the

His contemporaries never thought so;

— nor subsequent writers.

Mr. Reid has altered the escapement from that published by Thiout.

* "M. le Roy l'ainé est le premier qui ait pensé à cette sorte "d'échappement" Observations sur la Physique, &c. par M. l'Abbé Rozier, T. III. Part I. Juin 1774.

figure

Odrometer for a Carriage
by R L Edgworth Esq

Fig 1

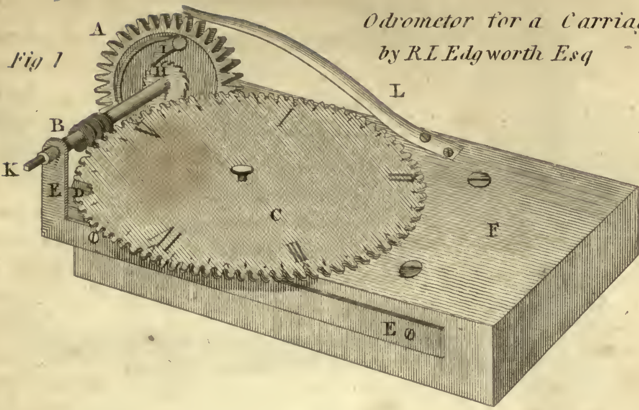


Fig 3

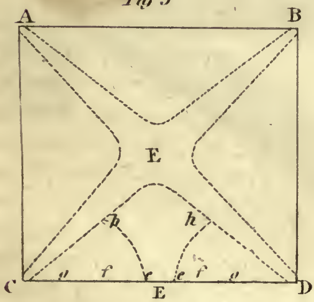


Fig 4

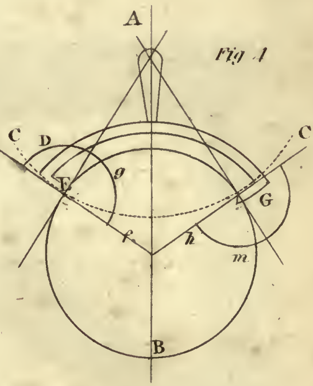


Fig 2

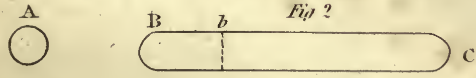
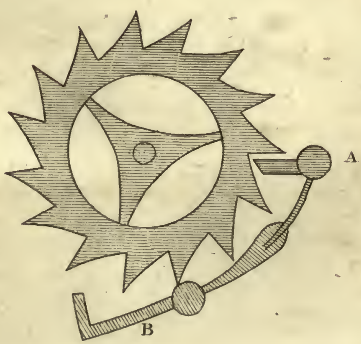


Fig 5



Mr. Parkers Machine for Shoemakers

Mr. Gilbert Gilpins Crane for raising Weights

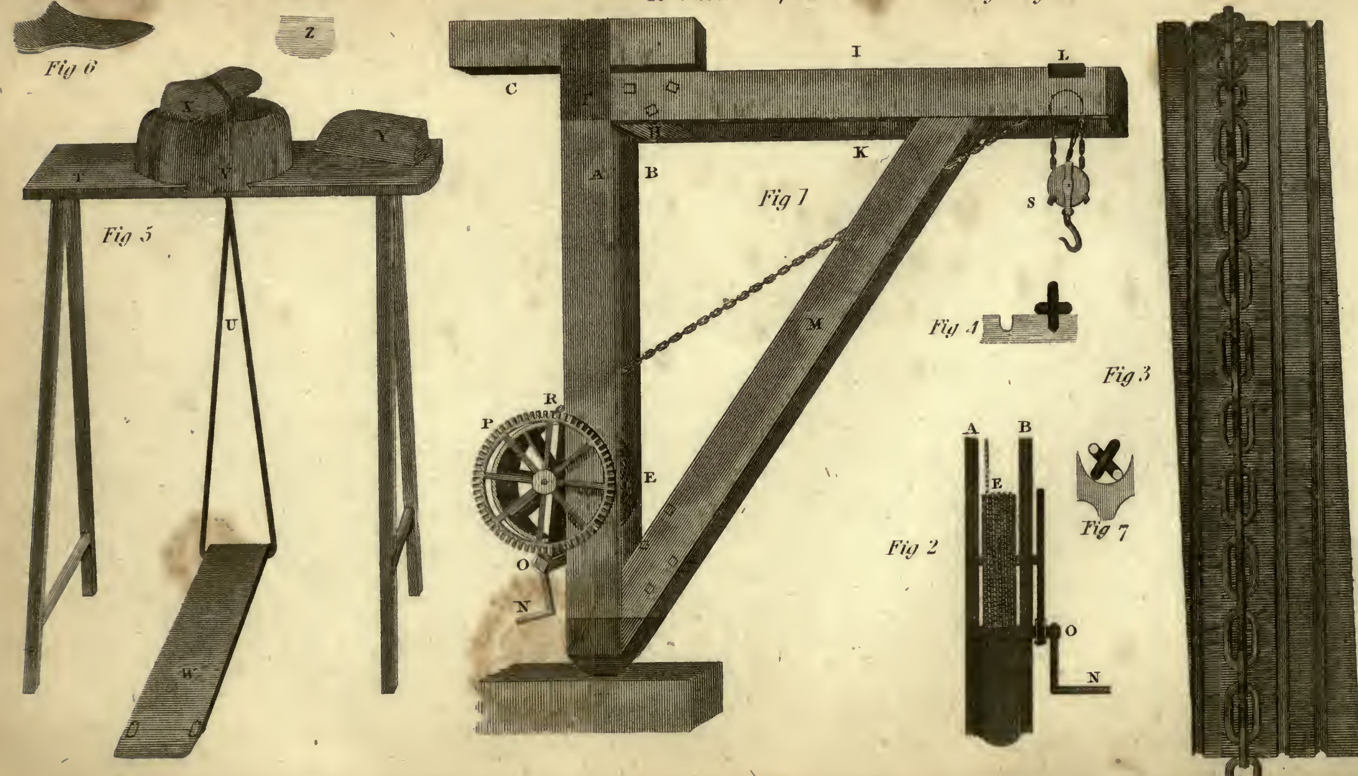


figure given in Thiout's work. Mr. Reid saves himself the trouble of referring to the passages of the books he quotes in the course of his paper; but, as our object is, not only to rectify, but to enable other persons to judge for themselves, we think it incumbent upon us to do it for him; and shall also annex a faithful copy of that part of the abovementioned work, from which he has taken the escapement here treated of, but which he has altered into a detached form.

— and has not quoted his original.

Fig. 5. Plate 3. is a copy of the representation given by Thiout (Fig. 30. Plate 43. Vol. I.), and the following is a literal translation of his explanation of that mechanism (p. 110. ditto): "It is an escapement of a watch in which half of the vibrations *seem* independent of the train of wheels, while they are performed. The detent B stops the escape wheel; the balance bringing back the pallet A, the detent recedes, to leave the escape wheel free to strike the pallet; and so on. This escapement could not perform without a spiral spring*."

Correct copy and translation here given.

From the preceding description, it plainly appears that this escapement acts with a single pallet, and a detent to stop the train of wheels during the intervals that elapse between the successive communications of the maintaining power; but that the balance in it, is never disengaged from the detent; consequently this construction does not possess the distinguishing principle of the detached escapement. Mr. Reid has made it a very different thing, by introducing certain alterations, which will be easily perceived, on comparing his figure with that of Thiout. He has broken the communication between the detent and the pallet, and provided the former with a fork, which is not in the original; and the escapement, with these changes, seems, at first sight, capable of acting freely. Such, however, is not the construction given by Thiout;

Explanation. Thiout's escapement.

The detent moves with the balance during the repose of the wheel.

Mr. Reid's altered escapement seems to be free;

* For the reader's satisfaction, as well as our own, we subjoin an exact copy of Thiout's explanation: "Fig. 30. est un échapement de montre dont la moitié des vibrations *paroissent indépendantes* du rouage, pendant qu'elles se font. Le crochet B retient le rochet; le balancier ramenant la palette A, le crochet s'éloigne pour laisser le rochet libre à frapper la palette; et ainsi de suite. Cette sorte d'échappement ne sçauroit aller sans spiral." P. 110.

—but it is not Thiout's, and is incomplete, as a free escapement.

Thiout; and it may be farther observed, that the sort of mechanism represented by Mr. Reid is incomplete, and could never have been executed in that form, there being no provision to keep the detent, by a spring or otherwise, in its proper place, and prevent its getting disengaged in consequence of external motion.

Thiout himself did not set much value on this contrivance.

Thiout was so far from attributing to his escapement the merit which, after making it suffer a complete metamorphosis, is now claimed in its favour, that, in a section of his work where he gives very particular rules for the construction of many escapements, he rests satisfied, respecting this, with the short explanation we have already copied. With regard to the property in question, he says, not that it is, but that it *seems* detached; and this expression is, if possible, more conclusive, when the articles of the same chapter are read in their natural order. The passage above extracted comes after the description of an escapement (pp. 105 and 106) for pendulum clocks, acting with a single pallet and a detent, which was invented by Sully, and formerly published in the *Règle Artificielle du Temps*. Thiout's escapement is an imitation of the above mechanism, adapted to watches with a balance; and the opinion he entertained of the original, is positively expressed in the following words of his description: "It seems that half of the vibrations are independent of the train of wheels; but this is what experience does not prove*."

He made it in imitation of one of Sully.

Mr. Reid supposed to be partial to the escapement he has drawn.

There are no bounds to Mr. Reid's predilections in favour of Thiout's escapement, and he reminds us of a lover making the picture of his mistress, who cannot draw a feature without embellishing it, and, after all, produces a figure from which no one can form the least idea of the original. Not satisfied with placing the mechanism in question at the head of that most honourable branch of the family of escapements called detached; he represents the pallet under such a form as authorises him to conclude that Mr. Thiout's escapement is also the origin of the *échapement à virgule*. But Mr. Thiout has as little

By making the pallet curved, though straight in the original, he considers it as the origin of the virgule escapement.

* "Il paroît que la moitié des vibrations sont indépendantes du rouage; mais c'est ce que l'expérience ne prouve point." P. 106.

right to be esteemed the father of the last mentioned escapement, as of the detached. From the copy we have given of his figure, it will be immediately perceived, that the pallet of the original escapement is strait, and shews no marks of the curvature Mr. Reid has thought proper to bestow upon it, previous to his comments upon its shape.

We think it needless to expatiate more upon this subject. The copy of Thiout's book, which is now before us, is in direct opposition to the account Mr. Reid has given as an extract from it; and we cannot but suppose that the whole edition, which has been in circulation for more that sixty years, contains the same text and figures without variations. If Mr. Reid, however, can shew a copy with the description and figure as given by him, we shall willingly acquit him of the charge of misrepresentation; but, even in that case, we must still insist upon the fairness of our observations, which are warranted by the nature of the case, and called for by the interest we take in the history of Chronometry.

If there be any edition of Thiout to justify Mr Reid's drawing and description, he must be acquitted of misrepresentation. But the arguments here offered will still hold.

Mr. Reid seems animated by a violent desire of finding new things in, and deriving extraordinary conclusions from, publications which are generally known. He asserts that the invention of the compensation balance is due to Mr. Harrison; and quotes as a proof the following passage of a letter from Mr. Mudge to Count de Bruhl: "You will now permit me to speak a word or two, as to the compensation for heat and cold in the balance. It is the original method by which Mr. Harrison attempted to correct the error, which, as he was pretty tenacious of his own opinion, he carried into execution contrary to the advice of Mr. Graham, but found by experience that Mr. Graham was right, and was forced to throw it all away, and to contrive his method of applying it to the balance springs *."

Mr. Reid asserts that the compensation balance is Harrison's.

We have transcribed the whole of the extract given by Mr. Reid; and we now ask, What does Mr. Mudge's statement prove, even supposing his information perfectly accurate?

But Harrison did not complete it, and certainly never published it.

* This passage is in p. 150 of the correspondence published in 1799 by the son of Mr. Mudge.

accurate? viz. that Mr. Harrison attempted to provide the compensation for heat and cold in the balance, and that he miscarried so decidedly, that he was obliged to apply it to the spiral spring. How he endeavoured to accomplish it, is not known; therefore, any other person might be afterwards the real inventor of the same contrivance, and have the additional merit of succeeding in an undertaking where so great a genius had failed. Upon this ground, although the letter above quoted has been now published some years, and the report contained in it had been circulated long before its date, the invention of the compensation balance has been, in this country, generally ascribed to the late Mr. Arnold; and certain it is, that if there existed no other reason to invalidate his claim, the memory of that artist would continue to be accompanied with the credit of that important invention. But the invention of the first compensation balance that ever was executed, (that of the fluid thermometer), as well as that of the compensation balance upon the principle now universally used, are clearly due to P. le Roy; and the merits of the late Mr. Arnold, as an original author, in this respect, merely rest upon the supposition that he possibly may have had no previous knowledge of P. le Roy's writings. This, however, is foreign to our present object; and we shall conclude by remarking, that it is very probable Mr. Harrison never thought of using his metallic thermometer in the construction of the balance; this method being so simple and certain, that, if he had hit upon it, it could not have failed in his hands. From a passage in his last work*, it also clearly appears, that what he had in vain sought for was, the construction of a balance similar to his gridiron pendulum; and, as this passage has been frequently quoted in a mutilated manner, to shew the great difficulty and importance of the present method of compensation, we shall transcribe it entire, in order to produce the grounds upon which our opinion is founded: "And I can now boldly say, that if the provision for heat and cold could properly be in the

It is generally ascribed by the English to Arnold;

But it belongs to Le Roy;—

— and subsequently to Arnold, if we suppose him to have been ignorant of that artist's works.

If Harrison had thought of it, he would have completed it;

— but his researches were directed to the gridiron.

* A Description concerning such Mechanism as will afford a nice, or true Mensuration of Time, &c. 1765. p. 103.

balance

balance itself, *as it is in my pendulum*, the watch (or my longitude time-keeper) would then perform to a few seconds in a year."

Indeed, after the compensation for heat and cold was perfected in the pendulum, the first idea that would naturally occur to any person who wanted to correct the same errors in watches, would be, the application of a similar contrivance to the balance; and the method of a thermometer acting upon the spiral spring, could only be thought of in consequence of the first attempt proving abortive. But, let us repeat it again, in whatever manner Mr. Harrison tried to effect a compensation in the balance, the fact is, that he did not succeed; and, as his ideas upon the subject were never communicated to the public, the example of his endeavours, far from lessening, rather increases the merit of those artists who have actually accomplished that great desideratum in Chronometry.

His first attempt was probably in this way, and,

— was abandoned for the compensation curb.

R. M.

XVI.

Description of a Machine for the use of Shoemakers. By Mr. THOMAS PARKER*.

MR. Thomas Parker, the inventor of the machine, was desired to attend with it upon a committee appointed by the Society of Arts, on the 22d of November, 1804, and then informed them, that he had used this apparatus for twelve months past, and found it very useful. That all the work of shoe-making may be done with it standing; but that in some parts thereof he finds an advantage in using along with it a high stool; and that before he used this machine, he never saw or heard of a similar invention; and that he has found it of great service to his health.

Machine for shoemakers.

He stated the cost of such a machine to be about two guineas.

* Communicated to the Society of Arts, who gave a premium of fifteen guineas. See also our Journal, XIV. p. 155.

Fig.

Fig. 5. Plate III. Fig. 5, 6.—T. A bench standing on four legs, about four feet from the ground.

V. A circular cushion affixed to the bench, in the centre of which cushion is an open space quite through the bench, through which hole a leather strap U is brought up from below. This strap holds the work and last firm upon the cushion in any position required, by means of the workman's foot placed upon the treadle W.

X, Shows the last upon the cushion, with the strap holding it firm.

Y, An implement used in closing boots.

Z, A small flat leather cushion, useful in adjusting the last and strap.

Fig. 6. The shoe-last shown separate from the cushion. The round cushion is formed of a circular piece of wood, covered with leather or stuffed with wool or hair to give it some elasticity.

XVII.

On the Propagation of Electricity. By Dr. OERSTED*.

THE internal mechanism of the propagation of electricity, has not, I believe been hitherto explained. It is certainly very difficult to trace all the mystery of this process, but it is certain that many interesting consequences may be deduced from the very nature of the subject, and from the facts already known.

Phenomena of communication of electricity.

The first action of an electrified body upon one which is not electrified, is, as every body knows, to establish an electric polarity. Let *A*. Fig. 2 Plate III. describe an electric body; *B*, *C*, a cylindric conductor; *B* will acquire a negative electricity, whilst *C* becomes positive. This is denominated the *communication of electricity*. It is known also, that if the extremity *C*, of the conductor, be deprived of its electricity, the conductor will retain only the power of *B*, but on bringing *A* and *B* into contact, the

* Inserted in the Journal de Physique, Vol. LXII. May 1806.

contrary

contrary electricity is established in both A and C, which act is called the *electric distribution.* Communication is evidently the first, and distribution or division the second indication of electricity. We may denote the first act by the term, *first degree of electricity*, the second by *the second degree of electricity.* The former is a polarization; the latter an identification. By these denominations, we may avoid, even in expression, the false notion of a distribution. The electricity of the body A cannot be communicated from O to C, without employing some time, however short it may be. To explain this more clearly, we will imagine, after the manner of mathematicians, that space and time are divided into an infinitude of minute portions. Let us suppose the space infinitely small, wherein an electric polarity is excited; if, for example, during the first infinitesimal time, B be positive, $B\,b$ will be negative in B, and positive in b: during the second moment it will endeavour to augment the negative zone: consequently the positive zone will in like manner be extended, whilst the positive zone of B endeavours to establish a negative one farther off towards C. This process will continue till the negative electricity extends over the whole of the nearer surface of the cylinder, and the positive over the remoter surface, whilst the middle remains indifferent.

Zones of plus and minus.

—inferred to extend through all conductors.

The above process is to be understood as *continued* and uninterrupted, though for the sake of elucidation, and in order more clearly to describe the internal action of electricity in its propagation, it is here represented as *discrete.*

The propagation of electricity depends on the laws already laid down; for, admitting that each electricity excites its opposite, it is the very nature of the thing that it should be so propagated. But philosophers require to see their theories confirmed by nature in all points and under all circumstances. It is our intention to shew these proofs.

The electric fluid passes through good conductors at the rate of about a German mile in a second. In so rapid a course, it is impossible to follow the successive changes of negative and positive electricity: but with bad conductors

Electricity passes thro'one German mile per second.

ductors this may in some measure be effected. Hold a rod of glass, resin, or sealing wax, towards an electrified body; and on observing it with an electrometer, you will perceive the alternate zones of opposite electricity. This experiment is known to all philosophers.

It is needless to remark that we do not now speak of those infinitely minute changes from positive to negative, above spoken of, which, as we have already observed, we can never hope to distinguish; but to give a general notion of them, from their operation in these bodies. It might, however, be possible, to describe mathematically the number and properties of these zones.

The zones may be seen on bad conductors.

It is admitted that the foregoing mode of the propagation of electricity may be traced on bad conductors, and that it may even be observed in the air. We have then a right to consider the propagation of electricity as proceeding from *undulation*; which may be proved by other experiments. We cannot follow with the electrometer the rapid propagation of electricity on good conductors; but it frequently leaves traces upon them which confirm the opinion just advanced.

—and their effects in exploded wire.

If we attempt to melt a long thread of iron by means of a weak charge from the electric battery, we shall quickly perceive that one part of the thread is fused, whilst another remains entire, and that these parts are alternate. If a stronger charge be employed, the whole thread will be fused, and formed into small globules, which are produced by the expansive and contracted zones. The charge may be so managed as to give a red heat to the metal without fusing it; on which will afterwards appear evident marks of the transition of expansive and contracted zones.

The foregoing experiments are all well known to philosophers, and afford the strongest proofs of the undulatory propagation of electricity. But if the charge of the battery be augmented to such a degree as to volatilize the iron, and the experiment be so contrived as that the vapour may be caught upon a sheet of paper, we shall have a complete image of the propagation of electricity, in the clouds described upon the paper by the alternate transitions from expansion to contraction. The thickness

even

even of the smoke, and its colour change so regularly, that we may call it a coloured portrait of the oscillatory expansion of electricity. From the constant recurrence of the phenomenon, it is evident that this appearance is not an accidental effect, for let the experiment be made with any metal, the result will be similar without exception. Van Marum has in numerous and faithful representations explained this experiment, which may save us the trouble of repetition. The regularity of this image may be seen by another method. If electricity acted on the metallic thread by an expansive force solely, all the clouds of the vapour would be parrallel and straight; but as each conductor acts with a repulsive force on the nearest extremity of the thread, the clouds of vapour thrown to the two extremities by two powers which cross each other perpendicularly, follow the diagonal of those powers or rather, as the powers are constant and unequal, the clouds represent the image of a curved line, whose concavity is opposed to the metallic thread. The more distant a cloud is from one of the conductors, the less will it be affected by the repulsive force parallel to the thread, and the nearer will its position approach to the perpendicular force of the wire.

The smoke of metals exploded by large batteries.

Van Marum's experiments.

In the middle of the wire exists a perfect equilibrium of the opposing powers; and consequently the position of the shade will be exactly perpendicular to the wire.

The foregoing appearances will not be obtained if the force employed to evaporate it be too strong; but even in this case the figure will describe a zigzag, at each section of which, indications of the above order may be discerned.

An examination of the electric spark will afford us another proof. If the conductors, between which the spark appears, be pretty close, the spark is differently coloured at its two extremities, being red on one side and blue on the other, whilst the centre is white; but if the conductors be placed further apart, the spark will vary its colour as often as it makes transitions from positive to negative.

The electric spark shows undulation.

All that has been here observed of electricity is equally applicable to magnetism. The action of the load-stone originates

Undulation or zones observable in magnetism.

originates in polarization, and like electricity, communicates its powers with an undulatory motion. One zone of polarity must acquire its maximum of expansion, and thus give rise to another. This is confirmed by experience; for in magnetising a very fine steel wire, it acquires the alternate poles of north and south, in its whole length.

To understand the propagation of magnetism, we must reflect a little upon its production; and examine what effect is produced by drawing a magnet over a bar of steel: the two poles are impelled forward, so that the part which was $+m$ becomes $-m$; like a wave of the sea, which fills up a furrow before it, whilst it leaves another behind.

All the operations of nature are thus propagated.

This mechanism in the action of undulatory propagation, is doubtless general in all the operations of nature; but it is very difficult to shew it. It has long ago been observed, that the compression of a small portion of air is succeeded by its expansion, whereby contiguous portions must be compressed, and these, by expanding in their turn, compress others, &c. It is thus that the communication of sound through the air has been accounted for; but this mode of communication has not yet been suspected to take place through solid bodies.

Chladni's experiments.

The majority of philosophers oppose the discovery of the celebrated Chladni*, of the tremulous motion of the particles of bodies in the production of sound. But nothing is more easy to demonstrate both from the nature of the thing, and by experiments the necessity and the existence of this tremor. We need not much insist upon the theory, because the same proofs which are adduced to demonstrate the undulatory communication of sound through the air, may be applied to all other bodies; besides as motion cannot be communicated without employing some portion of time, all the particles cannot be similarly affected at the same moment.

Experiment with a wire and Lycopodium.

This is manifested in the following experiment: cover one of the extremities of a steel wire with powder of Lycopodium, and then strike it with a sharp and moderately

* Inserted in the Journal de Physique, Vol. 47, p. 390.

hard

hard blow, the powder will be divided into small heaps, describing a line, the length of the wire; those nearest the point struck will be the largest, the others will gradually diminish in size as they lie further off. This experiment may be made in a still more simple manner: take a square of glass or metal, whose edges are quite even, cover the surface with powder of lycopodium, and hold it with the fingers by opposite sides, leaving the other sides quite free. If one of the free sides be struck with a piece of wood, the powder will be immediately thrown into lines parallel to the direction of the blow, in which may be observed many elevations and depressions. But if the blow be given with a rough board, on the whole extent of the edge, the powder will dispose itself in lines parallel to the side struck. The lines will be more or less wavy, in precisely the same degree as the side struck was more or less even. If one of the surfaces be struck, a number of little heaps will be formed. This is doubtless the result of an oscillatory movement, and most decidedly of a progressive and an undulatory motion.

—and also with a square plate.

But if the tablet be held between the finger and thumb upon the two surfaces, without touching the edges, and a blow be given on the upper surfaces, not only heaps are formed by the powder, but a sound is emitted. The heaps receive a motion which obliges them to reunite at the extremity and they nearly assume the figure described by Chladni. Prepare the whole as if to obtain the figure of Chladni, using lycopodium instead of sand, and the figure will gradually appear. At the first blow the heaps will be formed like small knots, ranged about the points where the largest were formed. Let $ABCD$ (Fig. 3, Pl. III.) represent the tablet struck on the point E; the heaps described by $e\acute{e}$, ff', gg', &c. will be formed: $e\acute{e}$ will be formed sooner than ff', and ff' sooner than gg'. The first on the point E, and on all the line EE', will be driven towards E'; but that on e and $\acute{e}$ will be determined by two powers in the direction EE or ED and EE', it will then describe the curved line $\acute{e}h'$, and all the other points will traverse similar lines.

Figures formed by lycopodium on glass, &c.

In this manner the curve $CE'D$ will be described; and as all the other squares of the tables $AE'C$, $AE'B$,

A

A E' D, will have received oscillations at the same moment, they will form as many curves, altogether forming a kind of cross or star. It is to be observed that the lines at rest are not described by heaps of dust, but are surrounded by them. These lines cannot be described in the ordinary manner by the scattered sand, because it is elastic, and its particles are too considerable for each one to continue in motion untill it finds a tranquil and appropriate place. If two grains of sand be thrown upon a square of glass, thrown into motion by means of a bow, the experiment will confirm what has been just laid down. Consequently, the lines of powder must not be confounded with the lines of repose, which are denominated lines of knots. *The powder, on the least motion*, detaches itself from the lines of knots, as is seen in the experiment; but it is very difficult to detach it from the lines of sand. Hence we may suspect that the undulatory movement excites a degree of electricity, which is doubtless negative in the lines of knots and positive in those of repose, since the negative lycopodium is attracted by it. It is probable that all philosophers are acquainted with what Ritter has said on this subject in Voigt's Magazine.

LECTURES ON SURGERY.

Mr. A. CARLISLE, F.R.S. F.L.S. and Surgeon to the Westminster Hospital, intends to deliver a Course of Lectures on the Art and Practice of Surgery, in all its Branches, during the present Season, at his House in Soho Square.

The History and Treatment of the Diseases and Affections, which belong to the Province of Surgery, will be fully investigated; the several Methods of Practice examined, and accompanied with such Observations as the Lecturer's Experience may furnish. The various Chirurgical Operations will be demonstrated, and the Anatomy of the Parts explained, together with the Deviations, Accidents, and Difficulties which occasionally happen, and the Rules to be observed in each Instance.

An Introductory Discourse, (open to all Students) comprising the Plan of these Lectures, will be given on Monday, October 13, at Seven o'Clock in the Evening. And the Lectures will be continued on Mondays, Wednesdays, and Fridays, at the same Hour.—Tickets for the Course, Three Guineas; perpetual, Five Guineas.

A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY

AND

THE ARTS.

NOVEMBER, 1806.

ARTICLE I.

Experiments and Observations on the Adhesion of the Particles of Water to each other. By BENJAMIN, *Count of Rumford, F. R. S. &c. Communicated by the Author to the National Institution of France, and transmitted to him by the Editor.*

(Concluded from page 159.)

To prove this fact in another manner, I again varied the experiment, by placing a stratum of ether immediately upon the mercury. The particles of this liquid appear to have very little adhesion to each other; for which reason I imagined that the kind of film that would be formed at its surface, must have very little force. The results of my experiment fully confirmed this conjecture. A stratum of ether upon mercury—

The very smallest spherules of mercury which I let fall through this liquid, seldom failed to mix immediately with the mass of mercury on arriving at its surface, where they entirely disappeared; and I have never succeeded in causing either a spherule of mercury, or the smallest metallic particle, nor any other body of greater specific gravity than ether, to swim upon its surface. — appears to afford no resistance to descending bodies.

Alcohol.

The results of the experiment were not perceptibly different when alcohol was substituted in the place of ether.

The evaporation of ether—

It is known that ether evaporates very rapidly. Is not this another proof that the particles of this liquid adhere to each other with much less force than those of water? But the following experiment proves this fact in a decisive manner.

EXPERIMENT VII.

is incomparably greater than of water, and shews less adhesion.

Having half filled a small cylindrical glass with mercury, I placed on the mercury a stratum of ether four lines in thickness, and blew upon the ether with a pair of common bellows.

In less than one minute the ether had disappeared.

The same experiment being made with water, no sensible quantity of this fluid had disappeared in one minute.

Dust, which has no adhesion, rises by the wind;

The objects which are before our eyes from the earliest periods of our lives seldom employ our meditation, and not often our attention. We see, without surprise, immense masses of dust raised by the winds and carried to great distances; and at the same time we know that every particle of this powder is really a stone, almost three times as heavy as water, and of a size so considerable, that its form may be perfectly seen by means of a good microscope.

And we see also, without surprise, that water, which is much lighter than dust, and is composed of particles incomparably smaller, is not carried off by the winds in the same manner.

—but those of water do not.

In order to convince ourselves that the particles of water do strongly adhere to each other, and that they require to be so in order to prevent the greatest confusion in the universe, we need only figure to ourselves the inevitable consequences that would result from the want of such an adhesion.

If they did not adhere, they would rise more easily than dust.

The particles of water would be raised and carried off by the winds with infinitely more facility than the finest and lightest dust. Every strong breeze setting in from the Ocean would bring with it a great inundation. Navigation would be impossible, and the banks of all the seas, lakes, and large rivers would be uninhabitable.

The adhesion of the particles of water to each other is the cause of the preservation of that liquid in masses. It covers the surface with a very strong pellicle, which defends and prevents it from being dispersed by the winds. Without this adhesion, water would be more volatile than ether, and more fugitive than dust.

But the adhesion is also the cause of other phenomena, which are of the greatest importance in the phenomena of nature.

Hence all bodies may be suspended in water.

The viscidity which results from the mutual adhesion of the particles of water renders this fluid proper to hold all kinds of bodies in solution; as well the most heavy as the lightest; provided always that they be reduced to very minute particles.

Calculation of their size.

I have found by a calculation, founded on facts which appear to me to be decisive, that a solid spherule of pure gold, of the diameter of one 300,000th of an inch, would be suspended in water by the effect of its viscidity; even though this small body should be completely wetted and submerged in a tranquil mass of the fluid *.

The nutriment of plants and animals is thus conveyed.

This viscidity, or want of perfect fluidity, which causes it to hold every kind of substance in solution, renders it eminently proper to become the vehicle of nourishment to plants and animals; and we accordingly see, that it is exclusively employed in this office.

If the adhesion of the particles of water to each other were to cease, and the fluidity of this body were to become perfect, every living being would perish by inanition.

May I be permitted to remark the simplicity of the means employed by Nature in all her operations—May I be permitted to express my profound admiration and adoration of the Author of so many wonders!

* Fragments of gold leaf, which are about one-280,000th of an inch thick, subside in water with considerable velocity. This, however, does not invalidate the argument in the text. N.

II.

Abridged Extracts relating to the means used to reduce the weight of Horse Jockies and the methods of Training Horses, so as to augment their Strength, Wind, and Speed. From Sir John Sinclair's *Pamphlet on Athletic Exercises.*

SIR Charles Bunbury transmitted a letter from W. S. Rickword, Esq. who after mentioning some of the difficulties of collecting information from many of the persons of the class who practise the arts in question, proceeds to give the following observations, p. 65.

Physic is not much used in training men or horses.

"Physic of no kind is used now, so common as it used to be, either in wasting men to ride, or in training them to pugilistic engagements, or extraordinary muscular exertions of any kind. The number of questions put by this author might be compressed into a very few; like summoning and capitulating commanders of armed men, many of the articles are said to be answered in the foregoing, number so and so, as the numerous questions* (made use of in this pamphlet) are (in a great degree) by the following general observations. The good effects of air, exercise, and aliment, to animal bodies, to the attainment of health, is tolerably well known. No general rule can be laid down as to the mode of feeding; the quantity of exercise, or the time required, to bring either man or horse to perform the utmost he is capable of doing: the conformation, and idiosyncrasy of the body of each animal, the trainer should make himself acquainted with; men and horses differ in constitutions, as in dispositions. The great art amongst trainers is, *or should be*, to discover what quantity of exercise, &c. a horse will take to bring him to, and keep him at his best. As to physic, it is my opinion, that it is much too generally in use amongst racing horses in particular; but, upon that subject, I have more to say than is convenient for me to advance at present. More depends, far more, on exercise than is generally believed, even at this period, though the benefit is pretty well known and admitted; yet, by no means

Feeding not subject to any general rule.

Exercise, air and thorough grooming required by horses.

* See our Journal.

sufficiently;

sufficiently; pure air, proper exercise, good oats and hay, with thorough grooming, would bring horses to the starting post, far better able and in condition for running than they usually are brought, in consequence of the *too common* use of physic, and the quantity given at each dose. I am persuaded that alterative medicine would answer a better purpose than stronger physic, in most cases, where, even it is exhibited judiciously; I do not say, that physic is at no time proper, there are situations, when it is highly necessary; but I contend against the frequency of its exhibition, and the quantity exhibited; I do so, thoroughly convinced of its laying the foundation of some diseases, and rendering the animal incapable of contending against any other, with which he might unfortunately be attacked. As to the food used in the training of men, I should consider that which affords the most nutriment, occupying the least space, and digesting easy, to be the most proper, and likely to give the greatest assistance to the other requisites, in training them to perform any feats requiring extraordinary exertion of the muscular system; this attended to, with the benefit of free respiration (without which, nothing great can be performed, either by man, horse, or other animal) will admit of astonishing and wonderful powers and strength, either in wrestling, pugilism, walking, running, &c. &c.

Food for training men.

"As far as relates to strength and wind, the foregoing observations apply to fowl, as well as other animals. Fighting of all kinds I am an enemy to; cocking I never see, nor do I like to hear of it. The foregoing observations are hastily written, but rest on the best foundation."

Fowls.

Mr. Sandevir, an eminent surgeon at Newmarket, returned in substance, the following information to Sir John Sinclair.

The training of jockies of high repute is continued or kept up, more or less, from about three weeks before Easter to the end of October, which is about eight months: but a week or ten days are quite sufficient for a rider to reduce himself from his natural weight to a stone and a half below it. They breakfast very sparingly on bread and butter, with tea; dinner, fish, or else pudding with very

Particular account of the training by which jockies are reduced in weight, &c. It consists in taking little food and sharp exercise.

very little meat; wine diluted with twice its measure of water is their drink: tea in the afternoon with little or no bread and butter, and no supper. It appears that abstinence is their principal object.

As to their exercise, they load themselves with clothes, that is, five or six waistcoats, two coats, and as many pair of breeches; in which dress they take a severe walk of fifteen or sixteen miles after breakfast. On their return, they change their clothes for dry, and some who are much fatigued, will lay down for an hour before dinner. No severe exercise is taken after dinner; but the day is passed as they please. They generally go to bed at eight or nine, and rise about six or seven.

Those who are unwilling to take excessive exercise, have recourse to purgative medicine; which usually consists of two ounces of Glauber's salts.

This treatment recommended against corpulency.

Mr. Sandevir is positive in recommending a similar process for reducing corpulency in either sex, as from experience he perceives that the constitution does not appear to be injured by it: but he is apprehensive that very few indeed could be prevailed upon to submit to such severe discipline, unless he had been early inured to it.

Extreme case of sudden reduction.

This gentleman mentions as an additional fact, that John Arnall, when rider to the Prince of Wales, being desired to reduce himself as much as he possibly could, for a particular purpose, abstained from animal and even from farinaceous food for eight succeeding days, and eat only a piece of apple now and then. He was not injured by it at the time, and is now in good health. The writer also adds that Dennis Fitzpatric, a person at this time continually employed as a rider, declares that he is less fatigued by riding, and has more strength to contend with a determined horse in a severe race, when moderately reduced, than when allowed to live as he pleased, though he never weighs more than nine stone, and frequently has reduced himself to seven stone seven pounds.

Another person answered the queries to the following effect.

Another account of jockies, &c.

Jockies are trained and reduced by abstinence and by sweating, in consequence of additional cloathing and long continued

continued walking. Neither their health nor their strength are impaired unless these practices are carried to excess. When much reduced they are peevish and irritable, but perhaps not less courageous than usual. Many of them are naturally lean, but some recover their weight very rapidly when the course of training is left off. Neither their health, nor their continuance of life appear to be affected by this practice.

Mr. Robson, an eminent trainer at Newmarket, gave in substance the following information respecting race horses.

Method of training race horses for the course.

The perfection of a race horse consists in his wind, which is innate in their breed, and degenerates when mixed or crossed with other horses. It is observed sometimes that the other species of horses go nearly or quite as fast as the slower kind of race horse, but they very soon tire for want of wind, whilst the running horse has the peculiar merit, from his wind, of bearing fatigue so much better than any other breed of horses. The perfection depends on their parentage and on the female most. The foal must have corn during its rearing, otherwise it will not grow in proportion, but grow lean in the haunches. Different individuals of the same family will greatly differ in their natural constitution. Good size, with strength and symmetry of form, are essential to the running horse; but the most essential qualities are activity in speed, and good wind. With regard to form, he should be broad, deep, and have great declivity in his shoulders, his thighs let down very low, the hocks stand far behind and from him, thence downwards to the next joint, short, &c. large bones are preferred. Each sex is alike for speed, but the horse bears fatigue better. The foal is kept in grass fields in the state of nature till broke, and well fed with corn, as he will eat it, and with hay where grass is scarce. The training is began at two years and a half. Soft meal is a cooling food, but laxative and injurious when horses are at hurrying work.

The running horse is of a superior race.

Exercise, cleanliness and good provender constitute the treatment.

Physic, food, &c. for race horses.

Race horses are purged two or three times a year; each course, perhaps three doses preparatory to their getting their training exercise. Mild physic which has no tendency to weaken, is made use of. (I suppose this to mean a moderate

a moderate dose). Oats are the most esteemed provender for horses; and of these they have three feeds daily, of as much as they can eat with appetite. Their drink is soft water at least twice a day, always cold, except during physic or illness. Their skins are kept perfectly clean when in the stable, by friction with the brush and curry-comb, which clean and brace the skin and muscles. It is necessary to health and strength that they should be sweated, and this is done by putting on a few extra clothes and cantering them five or six miles according to their age and other circumstances. They are exercised twice a day; a mile or so in a gallop before they take water; and afterwards a short or long canter, as circumstances and their constitution require. The training is completed by good keep and a proper proportion of work, which enables them to bear fatigue. This is kept up for two or three months only, and effects no more than a temporary change in the animal. Running horses certainly live as long as others; they are not sooner worn out by the treatment they undergo, but on the contrary they bear fatigue much better than other horses.

Mr. Holcroft's account of running horses and their treatment

Mr. Holcroft's observations in the same treatise, nearly coincide with those of Mr. Robson. This celebrated dramatic writer lived at Newmarket, in his youth, under John Watson, the groom, who was employed in the two-fold office of training the horses and riding them. John Watson died at a very advanced age. I quote Mr. Holcroft's words, page 77.

They are purged and exercised.

"When the racing season is over, these horses have most of them green meat for some time, and repose from their severe exercise; their high spirit and vices soon begin to shew themselves, much to the terror of timid boys. Having fed grossly for a time, they are regularly purged, I forget how often, but I believe every other day, for three doses; and that these purgations are repeated, at intervals, three times. They then gradually begin to increase their exercise, so that, early in the spring, they remain out of the stable about eight hours in four-and-twenty, and take what are called four brushing gallops, two in the morning's exercise and two in the afternoon's; a brushing gallop means a gallop of nearly a mile, beginning

ning at a moderate rate, increasing, and ending full speed. They are stinted in their water; the horse that blows the hardest, the most; their hay and oats are of the best quality; the hay is long in the stalk, and the seed shaken out; the oats are thrashed in a sack, and winnowed, and every care is taken to keep the horses from chaff and impurity of every kind. After feeding, their heads are muzzled. They are not allowed above six hours in the night; for they are supped up at nine, and out again at three in the morning; but they have the intervening hours in the day, between their morning and evening exercise. When they become wet, from the accidents of weather, or other things, they are carefully rubbed till dry. Each horse has a boy for the performance of all these particulars; they are occasionally sweated, I forgot how often; that is, they are heavily clothed, galloped nearly full speed for four miles, relieved from their violent perspiration, first by wooden scrapers, then by rubbing them till they are perfectly dry, and after a little gentle exercise, are taken home.

Stinted in their water.

Method of sweating.

I have spoken to the best of my memory of things that happened at least six-and-forty years ago, and concerning which, when I quitted Newmarket, I never imagined I should be more questioned. The skins of the horses are kept perfectly and peculiarly clean; severe perspiration is thought absolutely necessary. I see no reason to suppose that their lives are shortened; some of them live to a great age. Eclipse, I think, died above thirty.

They are not short lived.

III.

Second Letter from R. B. *on the Developement of Intellect and Moral Conduct in an Infant, during the earliest part of her Existence; being concluded at the fourth Month of her Age.*

To Mr. Nicholson.

Sir,

I thank you for inserting my paper on the Progress of Intellect in an Infant, and have now the pleasure of sending

Continuation of a register of the progress of an infant from twelve days old.

ing you the remainder of my notes on the same individual. As I have made it a particular point to keep close to what was actually written at the time, instead of trusting to any thing my memory might now suggest, you will find some repetitions and perhaps defects of style, which that resolution has prevented me from amending. The dates continue to express the age of the child, whose progress from one day to another became less marked, in proportion as her stores of knowledge and acquirement became greater when compared with the improvement of any short interval of time.

15th day of her age. Knows her mother at a short distance

Fifteenth day of her age. The infant decidedly knows her mother when near her; but doubtfully if distant. She has long known her when in her arms. Her acuteness of observation and the use of her hands improve, though slowly. She grows very fat and is indolent, probably from the constitutional habits of her age and growth, and perhaps from the less lively impression of surrounding objects to which she is now accustomed. I think she still shows me a marked preference of intelligent attention. This morning her mother was talking to her, and upon her giving some striking signs of pleasure, her mother called to me "do look at her,"—the infant instantly turned her head from her mother to me, and appeared highly pleased at my coming to her. This could scarcely be casual: if it was not, she must have made considerable progress in the knowledge of the shortest and most frequent sentences used respecting her, of which "do look at her," is certainly one of the most frequent.

—and is aware of the use of language.

19th. Diverted by other children.

Nineteenth day. She is highly interested and diverted at her brothers and sisters, who are running about the room and occasionally take notice of her.

23d. Endeavours to articulate.

Twenty-third day. The infant is very desirous of articulating, and makes many efforts, by varying the form of the mouth and position of the tongue. When she succeeds in producing the resemblance of a word or syllable she is much pleased and shews her satisfaction by motions of the legs and arms. She never makes this effort but when engaged and attentive to some person who speaks to her, and whose approbation she seems to court by an endeavour at imitation.

Twenty

Twenty-sixth day. She can without any difficulty utter many voluntary simple sounds at pleasure. Her wants being now more numerous and habitual, she betrays more impatience than formerly, at privations or inconveniences. This impatience appears to be grounded upon a moral deduction that she has a claim or right to be indulged.

26th day. More perfect in articulating:

It is to be observed that her health, appetite and sleep have hitherto been perfect, and she has become much fatter than at the earlier part of her life.

She was baptized three days ago, and of course does not yet know her own name; but she has long known the word "child," as denoting herself.

—knows that the word child denotes herself.

Sixth week elapsed. The infant very decidedly knows that the word "mama" denotes her mother, which word pleases her more than any other, except the word "child." She knows her own name and attends when called by it. Conversation fixes her notice, even though not addressed to herself; and she can utter many sounds without hesitation or effort, in the imitation of conversing or answering, very differently from her manner a few days ago.

6th week. Knows her own name and various other words.

Seventh week. Her preference, directed to her mother, myself, and other favourites, are now expressed in a variety of ways. She holds out her arms and leans beyond the equilibrium, in order to prevail on us to take her from her maid, at the same time that her looks and voice are perfectly intelligible and expressive.

7th week.

Ninth week elapsed. C—— is now more pleased to listen to distinct general conversation, than to common phrases addressed to herself. I suppose this preference to arise chiefly from the greater variety of tones and articulate sounds which are new to her, and perhaps from the interest she may take in the concomitant action of the speakers. Her general habits and use of the eyes have gradually improved in accuracy and minuteness. She has nearly, but not perfectly, a command of the vertical position of the head; and turns to the place whence a voice addressed to herself, proceeds. But she does not always perform this last action with certainty and precision. In the use of her hands she gradually improves; and particularly exerts this action in feeling or pinching the breast

9th week. Attends to general conversation.

—can support the head and look round by acting with the muscles on the neck.

while

Uses the hands but not in connection with the eyes.

while sucking. There is yet, however, very little connection between the hand and the eye. While she is at the breast, contemplating her mother's face, she occasionally stretches forth her arms and is delighted if her mother will lean forward and kiss her hand. Her smile, which originally seemed to denote simple pleasure, is now more expressive and intelligent. She laughs at being mocked or suddenly deprived of the breast; and waits with some eagerness for a repetition of the trick. The nurse's practice of covering the child's face with her pin-cloth, and then suddenly plucking it off affords her diversion. Keys rattled before her, or a nosegay held near her, are viewed with eager attention and prominence of the mouth; at the same time that she grasps her own clothes, but does not attempt to apply the hand to the object of attention. She has a very marked fondness for her mother, and shews it, occasionally, by applying her mouth, opened very wide, against her mother's cheek, making at the same time, a gentle noise expressive of affection.

Pleased with tricks and mockery.

Very attentive to objects held to her; but does not try to take them.

10th week.
No attempt to seize visible objects.

Tenth week. Though her improvement in connecting the action of the hands with the sense of sight is very evident in her manner of taking hold of her own clothes or her mother's neck-handkerchief, yet she makes no attempt to seize any thing, in consequence of first seeing it.

Peculiarity in the infant face; noticed by Hogarth:

Hogarth in his "Analysis" of beauty mentions as one of the characters of the infant face, that the iris or coloured circle of the eye, being nearly of the same size in all ages, bears a greater proportion than usual to the size of the face in young subjects. But there is another more striking and very general difference. In this infant, the bony edge which supports the eye-brow, being naturally low, the upper eye-lid at first covered part of the iris as it does in many adults; but when the face became full and prominent, as is the case with thriving children, the lower eyelid, being pressed upwards, covered more of the iris, than the upper. This effect is common with infants, but is, I think, never seen at a more advanced age.

—another still more remarkable.

11th week.
Attempts to speak or answer by sounds

Latter end of the eleventh week. The attachment of C—— to her mother seems to increase. She laments or whines when the servant carries her away. Her attempts to

to speak improve in manner and precision of answering when spoken to, which she does by a sound sometimes of pleasure and sometimes of mere assent or attention. These sounds considerably resemble those of a monkey we had some years ago, which was habituated to reply to kind language. Her mother, as well as myself, thinks C——'s power of mind and observation are at this time much superior to that of the monkey; but her education, or quantity of acquired habits, less.

—resembling the language of a monkey.

C—— refused to go from her mother to her eldest sister, but readily left her to come to me. She knows when her maid, though absent, is called to take her. The amusement of spinning a half crown on the table diverts her much, but she makes no attempt to seize it. If however it happens to touch her hand, she is greatly entertained, and seems to have a notion of possessing it.

Spinning a piece of money.

Twelfth week, or age nearly three months. The variety of tones and what may be called words which C—— can now command, are sufficient to make herself perfectly understood, as to pleasure or pain or the mental affections, without crying; and she certainly understands quite enough of language to apprehend all that her wants and powers require to be communicated. She does not yet attempt to seize any object, with her hand under direction of the eye.

12th week. Makes herself well understood.

End of thirteenth week. C——having been ill with a complaint in the bowels, has shewn the most marked partiality for me; so as to quit the breast to come to me, when I appear. I think this arose from an habitual conviction that I, as the adviser and director of the family, could do her good*. It is probable also that my greater personal strength and ability to walk about with her and also the facility with which she and I understand each other, might afford strong motives of preference, by giving her that amusement which beguiles pain.

13th week. In illness she is attached to her father.

She has often and long ago been carried to a looking glass, which amuses her. From various facts I am convinced

She knows that a looking glass

* The same attachment and conviction has always been manifest in the illness of her and my other children at later periods.

shows images only.

vinced she at present knows that the figures are not real persons, but represent herself and others.

Three months old. First connection of the hand with the sight.

End of the fifteenth week, or age exactly three calendar months. Yesterday C——, who has been assiduously watched for that purpose, did not move her hand to take up any thing; and to day, at six in the evening, she completely acted with the hand and eye in conjunction. It seems as if this operation had been projected and previously arranged in her mind. She raises her arm by the shoulder-joint to a level with the object she desires to take, and then by an horizontal sweep, brings her hand before her, opening and shutting the hand till she has clasped the object, in which she does not readily succeed. Anxiety and impatience accompany this manoeuvre, and, on the whole, she is a good deal vexed with the desire to possess in this new way and the difficulty of bringing her hand to the object. I think she uses her right hand with rather more success than the other. When she had, with both hands at once, grasped the tea tongs, she could not command the voluntary power of letting go and therefore cried from the confinement of her hands.

The operation was curious and seems to have been studied or planned.

3½ months. Articulation, language, &c.

Three months and a half old. That effort at articulation which nurses call telling a long story, was very earnestly practised at this period, and some days afterwards she became very troublesome, from a wish to seize whatever was in her view. That habit of tossing the arm up and down, which infants acquire, and to which some authors ascribe the use of the right hand in preference to the left, was also exhibited at about four months old*. And soon afterwards her knowledge of words and things was so far advanced, that she knew her hands and feet by

She knows her

* The argument is that infants are usually carried on the right arm, because it is stronger; and in this position, the right arm of the child being at liberty, is said to be exercised more readily and early. It does not seem however, that there is much force in this remark; for the nurse is as likely to carry them on her left arm, in order to have the free use of her own right arm; and even on the former supposition, it seems to me that the arm nearest the nurse, would probably be more fully exercised by taking hold of her, or her clothes, than the other, which for the most part can have no object within its reach. B.

name;

name; that is to say, she shewed them when asked "which is your hand,"—"which is your foot," provided her attention was not turned to other objects. hand and her foot by name.

To this period I carried my journal. The subsequent months were not noticed; and indeed in these she became one of the family as to general intercourse, making herself understood by all, and comprehending what was said to her to the full extent of her understanding and the simplicity of her wants. I shall not extend my communication by arguments and inferences; but will only take notice that children do not speak sentences, and indeed scarcely words before they are twelve or fourteen months old, though my narrative seems to shew that they possess ability to do it much earlier. On this subject I would remark that the latter part of the first year of the life of an infant, is a time of indolence; when most of their wants are supplied by attendants who are constantly with them; and in the lower ranks of society, they are so ignorantly treated that they do not speak intelligibly for years; and again that they seldom have their teeth till after the twelvemonth. I have known a child who had teeth at six months, and spoke many words very well at that period, with a knowledge of their meaning*; but though he was highly satisfied at his own performance, he did not find motives for proceeding in his labours after language, till about the fourteenth month, when he began to run about, and found his wants and views so multiplied under this new change of circumstances, as to require a greater share of diligence than he had found needful in the arms of his protectors.

The journal ends here.

Qu. Why do not children speak earlier than at twelve months?

Because their necessity for speech does not operate till they walk, &c.

—and they have not teeth.

Instance of a child who had teeth and spoke at six months; but did not persevere, nor was he more advanced at the twelvemonth than other children.

I remain,

Sir,

Your constant reader,

R. B.

* He is now a very intelligent, unaffected boy; but has no extraordinary claims to notice, either in his own opinion or that of others. B.

IV.

On the Culture of Beans preparatory to a Wheat Crop. By John Christian Curwen, *Esq. M.P. of Workington Hall, Cumberland*.*

Sir,

Cultivation of beans and wheat, &c.

THE offer of a premium by the Society of Arts, &c. for the culture of beans preparatory to a wheat crop, being, as I conceive, for the purpose of demonstrating the superiority of green crops over dead fallows; I shall be considered, I flatter myself, as acting consonant to the views of the Society, in offering a detailed account of my proceedings, more especially as it will appear incontestably, that, if any advantage has resulted from a trial under such very unfavourable circumstances, the most sanguine expectations may fairly be entertained of the general utility of the system.

The plot of ground on which the experiment has been made, contains forty-two acres, the soil is a stiff clay, so flat as to afford very little fall for the water. The least continuance of rain renders it unworkable, though it has been drained as far as was practicable. It was broken up in the spring of 1800, and in that and the following year was under oats, both crops very heavy; in 1802 it was set with potatoes; in June, they were run through with the potatoe harrow, and made quite flat before they could be stitched up again. The wet set in and continued so long, that the crop was in a great measure ruined, and the weeds got to such a head that it was not possible to get the ground cleaned. It was sown with wheat in November 1802, by great exertions, but it was in so very unfit a situation that the greatest part of the seed perished: above half was re-sown with oats, in April 1803, being as soon as it could be got upon. Immediately after the crop was got off (early in October 1803) the stubble was turned up: in many parts the grass was

* This communication was made to the Society of Arts, in three letters to the Secretary, which I have here given without abridgement.

so

Cultivation of beans and wheat, &c.

so thick and strong, as to make it difficult for the plough to get through it. The winter proved so mild that it had done it little good. In many parts the harrows could not break it, and the grass was obliged to be cut and carried off by the hand. The advantage of a second ploughing would have been great, but by attempting it I might have lost the season for getting in the beans; I was restrained therefore from attempting it.—Forty acres were drilled before the end of February 1804, with a drill of the construction of Mr. Mac Dougals, six feet wide, sowing the rows at twenty-six inches apart. The weeds and roughness of the land would not admit of the drills being kept exactly straight, which occasioned additional trouble in cleaning, as also some loss in the crop. Forty-nine and a half Winchester bushels were sown.—I have been thus particular, to convey a just idea of the uncommon foulness of the ground, and the difficulty I had to contend with in consequence of it. The beans came up extremely well, notwithstanding the extreme severity of the spring. No step was taken in cleaning till the 10th of May 1804; this neglect proceeded from the multiplicity of other business, and my over-man being unacquainted with the drill husbandry, and the advantages of beginning to destroy the weeds as early as possible; from the 10th of May till the middle of July, which was as long as it was practicable to continue, the ploughs and harrows were constantly employed, and it was twice hand-weeded during the time. The cutting of the beans commenced the 20th of August: had the weather permitted, it might have been a week earlier. The method followed, which I had practised with success the year before, was to cut and spread the beans thinly, and to leave them exposed to the sun two days previous to binding. By the 26th, the whole was cut, and the field cleaned by the 29th.—I gained by these means above a month, which on wet land is of infinite advantage; I had great mortification in finding, after cutting the beans, the stitches extremely foul, notwithstanding all the pains I had taken. Any thing so dirty as this ground could seldom be met with; the season was very favourable, and I began to clean it immediately; I gave it two ploughings,

Cultivation of beans and wheat, &c.

and in some parts three, breaking it with harrows, raking and hand-picking it. I had, by the 20th of September 1804, the satisfaction of seeing it in a better situation than any fallow in the neighbourhood, and began to plough for wheat; on the 29th it was completely drilled, rolled, and water-furrowed. My friend Mr. Green, a member of the Society, who visited the field, was so struck with the busy scene, that he requested to have the people and the horses counted. There were fifty-nine men and women, and thirty-one horses; fourteen single, and one double cart, four ploughs, four harrows, drill, roller, and water-furrow plough, a horse each. It took sixty-two and a half Winchester bushels of seed; I had sixty carts of compost per acre, composed of dung, ashes, and street-rakings, that had been collected during the summer, and laid in the most convenient situations to facilitate the work. The filling, leading and spreading of 2500 carts of compost was a work of some magnitude; the month of October proved so wet, that, had it been delayed a week later, I should not have been able to have accomplished it. The labour it cost me after the beans were cut was very little inferior to a regular fallow; notwithstanding, the result, with this increased expense, will be found to be in favour of the experiment. The tick bean, which was sown on thirty-nine acres out of the forty, produced more abundantly than the other bean, which was sent me by Messrs. North and Bridge, and, being a later bean, is not adapted to this climate. The crop was good; one stalk of the tick bean had 70 pods, and these produced 353 beans; the weight, four stone thirteen pounds the Winchester bushel; the other bean, four stone four pounds. The crop produced 2010 stooks; from a few stooks which were left out of the stacks for the purpose of affording specimens for the Society, I have reason to suppose they will yield ten quarts per stook, or 628 Winchester bushels. I estimate by the London seed, which is least productive. The selling price is five shillings per Winchester, which would make the amount £167 9*s.* 4*d.* The stooks had been exposed to the inspection of various persons who wished to see in what state the beans were, so that I suppose some loss in the quantity,

quantity. The following is taken from the over-man's day-book, and I believe the greatest attention was paid to have the expense correct.

Cultivation of beans and wheat, &c.

	£.	s.	d.	£.	s.	d.
49½ bushels of seed, at 5s. 4d...	13	3	11			
40 acres ploughing and harrowing, at 12s.	21	0	0			
8 days work with drill, at 7s. 6d.	3	0	0			
4 carts two days leading weeds, at 5s	2	0	0			
24 women cutting weeds, at 9d...	0	18	0			
				43	1	11
141 days ploughing and harrowing, at 5s.	35	5	0			
435 days work of women weeding, at 9d.	16	6	3			
45 days work of men, at 2s......	4	10	0			
				56	1	3
168 days work of women cutting, at 1s. 3d.	10	10	0			
30 men's days work, at 2s.......	3	0	0			
66 women's days work, binding, at 1s. 3d.	4	2	6			
22 men's ditto, making bands, &c. at 2s.........................	2	4	0			
				19	16	
27 men and horses leading the beans off the ground, at 5s.....	6	15	0			
18 women's days work, at 9d....	1	2	6			
Stacking and leading the beans..	7	15	0			
				15	2	6
				£134	12	2
Further expenses after the crop of beans was cut.						
Twice ploughing and harrowing 40 acres, at 12s.............	48	0	0			
Ditto 6 acres a third time, at 12s.	3	12	0			
2 carts 6 days, leading off weeds and stones, at 5s.............	3	0	0			
48 women picking, at 9d.	1	16	0			
10 men ditto, at 2s.............	1	0	0			
				57	8	0

Cultivation of beans and wheat, &c.

Value of crop 628 bushels, at 5s. 4d.				£167	9	4
Expense of sowing, cleaning, and reaping the beans,	£134	12	2			
Had the wheat been then sown, the balance in favour of the crop would have been				75	12	0
				£243	1	4
By further expenses as above	57	8	0			
	192	0	2			
Balance in favour of the green crop, giving credit for the expense of the fallow	51	1	2			
	£243	1	4			

The appearance of the wheat is most promising. It is my intention to take another crop of beans, which will most completely clean the ground, then give a second dressing of from 20 to 30 cart-loads of compost, and sow it with wheat and seeds in the spring.

Should farther information be requisite, I shall be happy to give it.

I am, Sir,

Your obedient servant,

I. C. CURWEN.

Workington Hall, March 20, 1804.

CHARLES TAYLOR, Esq.

DEAR SIR,

An opportunity offering by which I can send you a sample of my beans for the inspection of the Society, I think

Cultivation of beans and wheat, &c.

think it more advisable than waiting till the meeting of Parliament; should it occur to you that any further information is requisite, I will be much obliged to you to acquaint me with it. I think I may, without arrogating too much, say, the manner in which the crop was worked and got into the ground, and its present appearance, is not inferior to any thing which has been done in any part of the kingdom. The accounts of expense were kept with great care and attention. I shall be highly gratified in being successful in my application for the medal. Should any information be wished by the Committee, my friend, Mr. Greene, of Bedford-square, would willingly attend, as he expressed great pleasure at what he saw whilst we were putting in the crop. It has drawn the attention of the farmers in the neighbourhood; and when I come over it again, I hope they will be sensible of the advantages resulting from the plan. I am this winter trying an experiment in feeding milch cows, and selling the milk to the poor, who have hitherto been extremely ill supplied. I conceive, by feeding the cows with green food and oil-cake, I can furnish the milk as cheap, and with as much profit as in summer. I give each cow four stone of green food, at 1½d. per stone, four pounds of oil-cake at 1d. straw 2d. making the total one shilling. New milk is 2d. per quart—any thing above six quarts is profit. I have thirty cows, mostly heifers; these afford less milk; but I can dispose of them without loss in March or April, having no keeping in summer, or design to interfere with other farmers. I sell near two hundred quarts per day, besides my own consumption, farm-house, &c. &c. The cattle are in admirable order. I keep them in open sheds, and turn them out several hours every seasonable day. The crops here were in general good. I had an acre and three rood of carrots, which produced five thousand stone; the ground was by no means good; but they were sown upon ridges, gathered as high as possible, with a double mould-board plough, and kept well worked during the summer. My success will induce many trials. I give five pounds each day to my horses, instead of oats, which saves me sixty Winchester bushels per week, or £20. The Bishop of Llandaff

Cultivation of beans and wheat, &c.

Llandaff is very busily employed planting a hundred acres, mostly with Larch; not to interfere with him, I wait till next year, when I shall plant between one and two hundred acres, lately purchased.

With great respect, I am,
Dear Sir,
Your obedient humble servant,
J. C. CURWEN.

Workington Hall, Nov. 20, 1804.
Charles Taylor, Esq.

Dear Sir,

I wish to add to the communication I had the pleasure of making to you, respecting the culture of beans, that I have threshed out two stacks, and found the straw most admirable fodder. Horses are extremely fond of it; and I have, in no instance, found it to disagree with them, which I have understood to be frequently the case when the bean stands till it is quite withered. This advantage in favour of cutting the bean green had not occurred to me, and will add much to the value of the crop, and supply the place of oat straw, which is nearly of equal value with hay. I have not used any hay this season, but given bean and other straw with potatoes and corn, and find the horses in high condition. The experience of every year convinces me of the great saving in my plan of feeding, as well as its being the best food that horses can have for keeping them in condition and health. Lucerne and an equal quantity of corn will not keep the horses in the same condition as with potatoes. It is supposed this feed is not adapted to quick work: I can only say, I seldom travel less than eight miles per hour with my carriage-horses so fed, and I drove them thirty-five miles, a few days ago, in four hours and three quarters, and this without any injury or distress to them.

With respect, I am,
Dear Sir,
Your obedient humble servant,
J. C. CURWEN.

Workington Hall, Jan. 25, 1805.
Charles Taylor, Esq.

V.

On the Arrangement and mechanical Action of the Muscles of Fishes. By ANTHONY CARLISLE, *Esq. F.R.S. F.L.S.**

IT was my intention to have continued my physiological inquiries on the phenomena of muscular motion, by a series of chemical experiments; and to have communicated the result, when duly matured, to the Royal Society. But an unexpected request, made at a late period, for the Lecture of the present year, obliges me to defer those researches, and to limit the investigation of the subject I have chosen.

Introductory remarks.

The application of the motive organs of animals has already furnished examples of general utility by increasing our knowledge of mechanical powers; and the cultivation of this study promises still further improvement.

Peculiar structure of fishes.

The muscles of fishes are of a very different construction from those of the other natural classes. The medium in which these animals reside, the form of their bodies, and the instruments employed for their progressive motion, give them a character peculiarly distinct from the rest of the creation. The frame-work of bones or cartilages, called the skeleton, is simple; the limbs are not formed for complicated motions, and the proportion of muscular flesh is remarkably large. The muscles of fishes have no tendinous chords, their insertions being always fleshy. There are, however, semi-transparent, pearly tendons placed between the plates of muscles, which give origin to a series of short muscular fibres passing nearly at right angles between the surfaces of the adjoining plates. Lewenhoeck† appears to have overlooked these tendons, and the numerous vessels, which he describes in the interstices of the muscular flakes, I have not been able to discern.

Their skeleton is simple; muscles voluminous.

Tendons.

The motion of a round shaped fish, independent of its fins,

The motion of a fish

* Read before the Royal Society, Nov. 1805, being the Croonian Lecture.

† Phil. Trans. Vol. XXXI. p. 190.

fins, is simple; and as it is chiefly effected by the lateral flexure of the spine and tail, upon which the great mass of its muscular flesh is employed, whilst the fins are moved by small muscles, and those, from their position, comparatively but of little power, I shall only describe in detail the arrangement and application of those masses, which constitute the principal moving organs.

— explained from the structure of the cod.

For this purpose a well known fish, the cod*, has been selected as a standard of comparison for the muscles of other fishes, there being a conspicuous resemblance among them all.

The side fins and back fins regulate position, &c.

The pairs of fins have been considered as analogous to feet, but they are only employed for the purposes of turning, stopping, altering the position of the fish toward the horizon, and for keeping the back upwards. The single fins appear to prevent the rolling of the body, whilst the tail is employed to impel it forward.

Manner in which the fins act.

Each of those fins, which are in pairs, is capable of four motions, viz. of flexion and extension, like oars, and of expanding the rays, and closing them.

The extension of the whole fin is performed by a single radiated muscle, which is often supplied with red blood: the antagonist is of a similar character. The greater power of the extensor muscle (Vide Plate V. *a*, *a*.) shews how strongly it is required to act when employed to stop suddenly the progressive motion. A series of intervening muscles expand and close the rays.

In the act of extending the fin the interosseal muscles are passive. It is advanced forward edgeways and closed; but during its flexion, the rays are expanded, striking the water with its broadest surface: this action assists the tail in turning the fish. In the effort to stop, these fins are strongly retained at right angles with the body, by the force of the extensor muscles, the rays are expanded, and the effect is assisted by the tail turning laterally with its broadest surface forward.

The single fins, for the expansion and contraction of their rays, are furnished with two sets of muscles; one of which is situated at their roots, and lies oblique;

* Gadus Morhua of Linnæus.

(*bbbbb*) the other, parallel with the spines, to which the rays are articulated (*cc*). The fin has also a lateral motion, by which it is occasionally drawn out of a straight line; and by the co-operation of these muscles on both sides, it is kept steady whilst the body of the fish is turned oblique in swift motion, or in eddies. When placed near the tail, the single fins seem also to aid the effect of that instrument by increasing its breadth.

Explanation of the action of the tail.

The tail is the principal organ of progressive motion, and its actions are performed by the great mass of lateral muscles. There are a series of short muscles for the purpose of changing the figure of the tail fin, which arise from the spine and *coccyx*, and are attached to the rays immediately beyond their joints: (*dd*): their action is to expand the rays, and by partial contractions to alter the lateral position of the fin. Slender muscles are placed between the several rays, (*ee*,) whose office is to converge them previous to the stroke of the tail.

The muscles situated on the head are those, which act on the *membrana branchiostega*, the under jaw, *os hyoides*, *fauces*, and the globe of the eye.

Experiments on the action of fish deprived of their fins.

In order to determine the effect of the fins on the motions of fishes, a number of living dace*, of an equal size, were put into a large vessel of water. The pectoral fins of one of these fishes were cut off, and it was replaced with the others. Its progressive motion was not at all impeded; but the head inclined downward, and when it attempted to ascend, the effort was accomplished with difficulty.

The pectoral and abdominal fins were then removed from a second fish. It remained at the bottom of the vessel, and could not be made to ascend. Its progressive motion was not perceptibly more slow; but when the tail acted, the body shewed a tendency to roll, and the single fins were widely expanded, as if to counteract this effect.

From a third fish, the single fins were taken off. This produced an evident tendency to turn round, and the pectoral fins were kept constantly extended to obviate that motion.

* Cyprinus leuciscus.

From

From a fourth fish, the pectoral and abdominal fins were cut off on one side, and it immediately lost the power of keeping the back upwards. The single fins were expanded, but the fish swam obliquely on its side with the remaining pectoral and abdominal fins downwards.

From a fifth fish all the fins were removed. Its back was kept in a vertical position, whilst at rest, by the expansion of the tail, but it rolled half round at every attempt to move.

From a sixth fish, the tail was cut off close to the body. Its progressive motion was considerably impeded, and the flexions of the spine were much increased during the endeavour to advance: but neither the pectoral nor abdominal fins seemed to be more actively employed.

From a seventh fish, all the fins and the tail were removed. It remained almost without motion, floating near the surface of the water, with its belly upward.

These experiments were repeated on the roach*, the gudgeon†, and the minnow‡, with similar results.

Differences between the texture of the muscles of fish and other animals.

The muscles of fishes differ materially in their texture from those of other animals: they are apparently more homogeneous, their fibres are not so much fasciculated, but run more parallel to each other, and are always comparatively shorter. They become corrugated at the temperature of 156° of Fahrenheit, when their tendinous and ligamentous attachments are dissolved, and their serous juices coagulated. Under those circumstances the muscles lose their transparency, and the lateral cohesion of their fibres is lessened.

Mechanical arrangement and physiology of the lateral muscles.

But the mechanical arrangement and physiology of the lateral muscles of the body of fishes constitute my present object. These parts have already been described in a general way by Professor Camper, M. Vicq-d-Azyr, and M. Cuvier, to whom I am indebted for much useful information. They have been denominated *couches musculaires,* by M. Vicq-d-Azyr§, and *muscles laterals* by M. Cuvier‖. The term used by M. Cuvier seems very

* Cyprinus rutilus. † Cyprinus gobio. ‡ Cyprinus phoxinus.
§ Mem. étrangers de l'Académ. des Sci. de Paris. Tom. VII. p. 18 et 223.
‖ Leçons d'Anatomie comparée. Vol. I. p. 196.

appropriate

appropriate for the general division or class. But, as the flakes are arranged in distinct longitudinal rows, these rows must be considered as orders. And, as *couches* appears objectionable, I shall adopt *series* in its stead; distinguishing each by a word referring to its situation in the animal, viz. the dorsal, vertebral, abdominal, and ventral series.

They are disposed in flakes or series.

These series are composed of thin masses of muscle, or, as they are commonly called, flakes; which for the most part are thicker upon their outward edges, and become wedge-shaped toward their interior attachments. Each series is separated from the next adjoining by a membranous partition, which is most apparent between the vertebral and abdominal series.

Particular description.

The dorsal series (*ff.*) arises from the back of the head. In its course it is terminated on the upper edge by the bones, which support the single fins, and a membranous *septum:* at this part the flakes are thin. Its lower margin is bounded by the vertebral series, where the flakes become gradually thicker. The first flake is composed of longer fibres than the rest, and possesses more red blood. Those succeeding it range obliquely backwards. They are all joined together by cellular membrane, and shining fasciæ, which resemble the tendinous expansions in quadrupeds.

Toward the middle of the fish the flakes are thicker, and stand more perpendicular to the surface, becoming oblique and thin as they approach the tail; whilst the intervening fasciæ are most dense at each extremity. This series consists of forty-five flakes, a number corresponding with that of the spinous processes to which they are attached, and which does not vary with the growth of the fish.

The muscular fibres constituting each flake, run nearly at right angles with its anterior and posterior surfaces, and parellel to the length and surface of the fish; except that their posterior extremities incline somewhat inwards.

As the skull affords the ultimate fixed attachment of this series, and its moveable insertions are on the vertebræ, and the tail, it follows, that its combined action is to bend the whole body and tail towards one side; or, if

Particular description of the muscles of fishes.

the flakes contract partially, to give it a serpentine motion. To produce these effects all the other series cooperate.

The superior external edges of the flakes of the vertebral series (*gg*) form acute angles with the inferior external edges of those of the dorsal series, the apices of which point toward the tail: the flakes are larger, but their number is the same. The lower margin of this series is bounded by the central membranous partition, which has already been noticed to be more conspicuous than the other longitudinal divisions, and it apparently admits of greater motion.

The abdominal series (*hh*) is composed of flakes similar to the preceding. They range toward the tail, forming an angle with those of the vertebral series, the apex of which is presented toward the head. They are attached internally to the transverse and inferior spinous processes of the vertebræ. The ribs are placed in the line of the centre partition, and lie between the flakes. This series arises from a bone which borders the opening for the gills, and the pectoral fin, with its scapula and muscles, is situated between its foremost flakes. Wherever this series encloses the viscera, its flakes are shallow, and their thickness internally is not much less than at their external superficies.

Lastly, the flakes of the ventral series (*ii*) form acute angles with the abdominal flakes, the points of which incline to the tail. It is attached anteriorly to the *os hyoides*, and the bones of the lower jaw. In its course it is bounded above by the abdominal series, and below by a membranous *septum*, within which the inferior single fins arise. The flakes, that cover the viscera, are shallow; and they lie more oblique as they approach the tail. Both this, and the last described series, have their muscular fibres arranged according to the length and figure of the fish.

Three large superficial nerves (*kk*) passing longitudinally from the head to the tail, in the course of the membranous partitions, give off fibrils at right angles, which bend inwards between each of the muscular flakes. A larger set of nerves are sent from the *medulla spinalis*, one between

between each flake, the branches of which seem to enter without ramifying there. Another small nerve passing from the head, and running deep-seated, and close to the dorsal spines, crosses and unites with each of the spinal fibrils, and at the junction a remarkable body appears: it is a loose transparent vesicle, about the size of a millet-seed, containing a white substance like the carbonate of lime found in the intercostal ganglions of frogs. This vesicle is included within the sheath of the nerve.

Particular description of the muscles of fishes

The coats of the blood-vessels are of a delicate texture, and easily ruptured. In order, therefore, to secure them from being injured by the violent and sudden actions of the muscles, the principal trunks both of the arteries and veins are inclosed in osseous canals, formed by the bases of the superior and inferior spinous processes; and their first ramifications lie within grooves in the spines. As they pass out to supply the muscles, their branches are immediately subdivided, so that a considerable vessel soon becomes extremely minute.

Fish move with surprising velocity; nearly equal to that of birds.

The rate, at which many fishes move through a medium so dense as water, is very remarkable; their velocity being scarcely surpassed by the flight of the swiftest birds: and although the large proportion of muscles, and their advantageous application, may partly account for the phenomenon, yet the power would be inadequate to the effect, if it were not suddenly enforced; as is evident from the slow progress of eels, and such fishes as are incapable from their length and flexibility, of giving a sudden lateral stroke.

This extreme force is soon exhausted.

But the quickness and force of action in the muscles of fishes are counterpoised by the short duration of their powers. Those accustomed to the diversion of angling, are aware how speedily the strength of a fish is exhausted, for if, when hooked, it be kept in constant action, it soon loses even the ability to preserve its balance, and turns upon its side, fatigued and incapable of motion. This has been vulgularly attributed to drowning, in consequence of the mouth being closed upon the hook; but the same effects take place when the hook is fastened to the side, or tail. This prostration of strength may depend partly on fear, and partly on interrupted

terrupted respiration, since fishes, when swimming rapidly, keep the *membranæ branchiostigæ* closed, and when nearly exhausted, act violently with their gills.

The structure of their muscles forms a contrast to slow-moving animals.

The shortness of the muscular fibres, and the multiplied ramifications of the blood vessels, are probably peculiar adaptations for the purpose of gaining velocity of action, which seems to be invariably connected with a very limited duration of it. Such examples form an obvious contrast with the muscular structure of slow-moving animals, and with those partial arrangements where unusual continuance of action is concomitant.

These doctrines further illustrated.

Since my former communications on the subject of cylindrical arteries*, another instance of their supplying slow-moving muscles, which are capable of long continued action, has been pointed out to me by Mr. Macartney. It is in the muscles, which act upon the feet and toes of many birds, and seems to be an adaptation for the long exertion of those muscles while they sleep, and also when they alternately retract one foot under the feathers to preserve it from the effects of cold.

The muscles of the human body, which perform the most sudden actions, have their masses of fibres subdivided by transverse tendons, or are arranged in a penniform direction. The semi-tendinosus, and semi-membranosus of the thigh are thus constructed; the former having its fleshy belly divided by a narrow *fascia*, and the fibres of the latter being ranged in a half-penniform manner. The *recti abdominis* are also divided into short masses by transverse tendons, and all these muscles are conjointly employed in the action of leaping.

Perhaps these observations may indicate the reason for that diversity in the lengths of various muscles, which act together; thus, organs of velocity are joined with those of power, and mutually co-operate to produce a simultaneous effect.

DESCRIPTION OF PLATE.

Explanation of the engraving. Pl. V.

The drawing was made from a cod which had been coagulated by heat, in a case of plaister of Paris, the skin

* Phil. Trans. 1800, p. 98.—Also 1804, p. 17.

being

being taken away, and an equal portion of the flakes carefully removed from each series, to exhibit their several directions. The subject was reduced to the present size by accurate measurements.

aa, Muscles which extend the pectoral and jugular fins.

bbbbb, Oblique muscles, which erect the rays of the single fins.

cc, Muscles which depress the rays.

dd, Muscles which extend the rays of the tail.

ee, Interosseal muscles, which close the rays.

ff, The dorsal series of muscular flakes.

gg, The vertebral series.

hh, The abdominal series.

ii, The ventral series.

kkk, Three superficial nerves which run longitudinally between the series of flakes.

l, Posterior surface of a dorsal flake.

m, Posterior surface of an abdominal flake.

n, Anterior surface of a vertebral flake.

o, Anterior surface of an abdominal flake.

The middle portion of the fish from whence the flakes have been removed, shews the several directions of them, and also their different thicknesses. The spine appears in the chasm.

VI.

On the Use and Abuse of Popular Sports and Exercises, resembling those of the Greeks and Romans, as a National Object. By Samuel Argent Bardsley, *M. D.*

[From the Memoirs of the Manchester Society, Vol. I.]

HUMAN nature is so constituted as to require both bodily and mental recreation. This instinctive propensity to amusement in man, is sufficiently proved by the universality of the appetite, in every stage of life, under every variety of clime, and constitution of government. But the regulation of this natural propensity differs greatly

Recreation or amusement.

ly according to the circumstances under which he is placed. The recreations and sports of mankind are therefore diversified by the influence of moral, political and physical causes. The means of gratification are various and complex: the end simple and uniform. To escape from the sensations which may be induced by too great or too little exertion of body or mind, and to enjoy the pleasure which sympathy extracts from the varied intercourse with fellow man, give rise to that fondness for public diversions and sportive contests, so conspicuously displayed in the history of mankind.—The influence of physical causes, in regulating the nature of these diversions, may be readily conceived.

—is sought by man in order to change his state of re-action.

Influence of physical causes affect our amusements. Activity is seen in a cold climate, indolence in a hot one.

The hardy, strenuous and active amusements of the inhabitants of the temperate and frigid zones, would depress and exhaust, rather than enliven and invigorate, the residents of a torrid clime. Hence the supreme delight of the Asiatic consists in the enjoyment of those pleasures which are purchased with little fatigue of body, or agitation of mind. To inhale the grateful fumes of his pipe, and to foil his adversary in the stratagems of chess, or other sedentary games, constitute the principal part of his amusements.

Moral causes act likewise.

Although physical causes necessarily circumscribe the sphere of man's active pursuits, yet they have much less controul than those of a moral and political kind. Man is endued above all other animals with a frame and constitution which can adapt itself to every diversity of clime and change of temperature. He can, in a measure, subdue physical obstacles, when powerfully stimulated by moral and political causes.—The savage, compelled to hunt his prey for food, has little leisure to cultivate his intellectual taste and powers. If not exposed to danger from hostile neighbours, his recreations are mostly of a negative kind.—He is happy when idle and at ease. But if he be stimulated by the prospect of war, all his amusements tend to accomplish him for carrying on successfully his military exploits. His songs are praises of the heroes of his nation; and his dances are connected with martial discipline. The public shews and festivals

of

of his country are, almost without exception, of the character of savage war*.

Civilization encourages mental recreation

According to the degree of civilization will the public sports and amusements of a people partake more or less of the mixed character of corporeal and mental recreation. A display of the arts which refine and gladden life, can only flourish where the condition of man has been long meliorated by the enjoyment of moral and political advantages.—Indeed the kind and nature of the popular sports and exhibitions of a people, whether just emerging from barbarism, or passing through the various stages of improvement, or arrived at the highest pitch of refinement, serve to measure, as by a scale, the different degrees of their advancement to the acme of civilization. The two most powerful and celebrated nations of antiquity, Greece and Rome, afford ample proofs of the truth of this remark. The shews and public sports of each of these nations, while they issued from their character and manners, operated on this very character and manners, and rendered them more ardent and permanent. This connection between the character of a people and their sports, was forcibly impressed on their legislators and rulers. Their public games were instituted for other purposes than mere amusement and relaxation. They were rendered subservient in Greece to the noblest views of legislative policy. Intimately connected with the whole system of government, whether civil, military, or religious, they had a moral as well as a political tendency. To promote ardor, emulation, friendship, patriotism, and all the animated principles and connections of active life, the Olympic and other solemn festivals were instituted. In

Whence the state of barbarism or refinement may be measured from the public sports.

Legislators have often directed the public sports to moral and political objects.

* The savage tribes of America furnish various proofs of the truth of this remark.——Likewise in Collins' account of the natives of New Holland, there is a curious illustration of the propensity of a rude and savage people to those amusements which are adapted to their peculiar situation.

Indeed the singular and ludicrous ceremony of initiating youth into the rank of warriors, at the celebration of their military exercises and games, is a striking instance of that disposition to amusement, which even the most savage and wretched state of life cannot eradicate.

order to investigate some of the moral and political effects of these popular sports and public games, which contributed so largely in raising the Greeks and Romans to a height of unparalleled grandeur, it will be necessary to examine the foundation of a system, which, in some respects, when freed from its worse abuses, particularly those which the more ferocious character of Rome introduced, may not illaudably nor unusefully be imitated by the most civilized nations.

The ancient Greeks directed their sports to afford pleasure and to give agility and personal power.

Though it may, perhaps, be admitted, that the difference in the state of knowledge and general policy, in the ancient and modern world, will not admit of a close approximation in the system of their public sports and amusements; yet the principles to which the Greeks directed their attention in controuling popular amusements deserve the limited imitation of every free and enlightened people. For, their aim was to direct to innocent and useful objects two of the most powerful principles of the human breast;—the love of pleasure and the love of action. Hence arose the institution of the * gymnastic exercises, which formed the principal part of all the solemn games. The gymnastic art consisted in the performance of bodily exercises calculated for defence, health and diversion. That branch of these exercises, called the athletic or sportive, must be considered as coeval with the formation of society †. The five ‡ gymnic exercises, so

The athletic sports are practised by all nations.

* Lycon, according to Pliny, first instituted the gymnastic games in Arcadia, whence they were extended throughout Greece and successively contributed to the highest gratification of both the Greeks and Romans, in their private schools and public solemnities.

They were performed in the *Gymnasium*, where not only youth were instructed in these exercises, but also the philosophers taught their different doctrines.—The Palæstra, which formed a part of the building, was the school for the gymnic exercises.

† In almost every island of the Great Pacific Ocean, we find a similarity, more or less striking, in the athletic and warlike exercises of the natives, with those practised in Greece.

‡ These five exercises were called Pentathlum by the Greeks, and Quinpertium by the Romans. They consisted of leaping, running, throwing the Discus, darting the javelin, and wrestling; but instead of darting the javelin, others mention boxing. The last exercise

so accurately described by Homer, Pindar, Sophocles, and Pausanius, formed the principal branch of the education of youth.

To be enabled to excel in the performance of these, they were trained with the greatest care; and every means was employed to excite powerful emulation. Their object was, to recreate and strengthen the body, as well as fortify and exalt the mind. For, the firm organization acquired by perpetual exercise, counteracted the propensity to vicious indulgence, which a voluptuous climate naturally inspires.

How the Greeks were educated.

They likewise infused a courage depending on animal strength and vigour, which was excited to the highest pitch among this warlike people *. Besides, the ambition of honest fame (the sure † reward of excellence in these sports and contests) taught them to controul the appetites of the body by the affections of the soul.

Animal vigour gives courage.

But the chief aim and end of the institution of athletic gymnastics among the more warlike states of Greece, were, perfection in the military character. Their philosophers inculcated this doctrine by their precepts and example.—Plato, in his book of laws, after having viewed the high importance of acquiring bodily force and agility, adds, "a well governed common-wealth, instead of prohibiting the profession of the athletic, should, on the contrary, propose prizes for all who excel in those exercises, which tend to encourage the military art."—And, perhaps no better plan could have been contrived to foster a warlike spirit amongst a people devoted to military enterprize, than the training of youth in these hardy and laborious exercises, and in proclaiming rewards for those

—and renders men capable of defending their country by military art.

ercise was combined with wrestling; and then took the name of Pancratium.——See Hieronymus Mercurialis, de arte gymnastica—and Potter's Archœologia.

* Hac arte, Pollux & vagus Hercules
Innixus, arces attigit igneas.—Hor.
"Thus mounted to the towers above,
"The vagrant hero, son of Jove."

† Such as gained victories in any of these games, especially the olympic, were universally honoured, and almost adored.——See Plutarch's Sympos. lib. II. Quest. VI. and Potter's Archæol.

 who

Mere strength or animal courage is attended by ferocity.

who excelled in their public exhibition. If man were only destined to conquer and triumph over the weaker and less valiant of his race—if the lust of dominion were the only appetite worthy of gratification, then the cultivation of bodily prowess and ferocious courage would properly form the business, as well as pleasure of life. But man has a nobler part to act in society; and enjoyments more pure, lasting, and better fitted to the dignity and character of his nature, become necessary to his well being in an advanced stage of civilization. It may readily be conceived, that those arts which sooth and embellish human existence, and which depend on the cultivation of feeling and of taste, would be neglected by the Greeks, when only bodily strength, activity, and address could carry off the palm of victory. In the distracted state of the first settlers in Greece, when the bodily energies were constantly in action, courage and personal strength decided the day in most of their military conflicts. Hence courage became associated with every idea of patriotism, honour, and virtue. It is the opinion of Aristotle, "That the nations, most attentive to the formation of the body, strive to give it too athletic a habit, which injures the beauty of the shape, and stints the growth of the person. The Lacedemonians avoid this error; yet, by imposing excessive labour on the body, they engender ferocity in the mind, thinking this conducive to martial spirit. But mere warlike courage, taken separately by itself, is a doubtful and defective quality, and, cultivated too assiduously by the hardening discipline of toils and struggles, will degrade and debase the *man*, blunt his faculties, narrow his soul, and render him as bad a soldier as he is a contemptible citizen *." This necessity of rendering the gymnastic art subservient to nobler pursuits, was felt and acted upon by the Athenians, and other polished states of Greece.

Men who have only animal strength and ardour will not be good soldiers.

The Greeks cultivated poetry and music as part of their public games.

The cultivation of poetry and music was encouraged by bestowing the highest honours and rewards on those who excelled in these delighful arts at the celebration of all the public games. To such a happy combination of

* Gillies's Aristot. polit. p. 250.

mental

mental with corporeal excellencies, cherished and displayed under the most pompous and fascinating appearances in their popular diversions and solemn festivals, may the splendid achievements of this distinguished people be attributed*. Considered in the light of affording amusement, exciting generous emulation, and of creating robust and hardy citizens, endowed with energy to resist slavery at home, and enemies from abroad, the gymnastic exercises, with some exceptions, and under proper regulations, are worthy of the admiration and imitation of all free and civilized states. But there was another kind of popular sport, common to the less polished states of Greece, and which has been practised by mankind, not only in the rude and barbarous, but (to the disgrace of humanity) in the most advanced and polished period of civilized life. This amusement depended on the contests of ferocious animals, whose natural antipathies were made use of, and designedly inflamed to gratify a depraved and barbarous taste.—"They delight," says Lucian, (speaking of the Greeks,) "to behold the combats of bold and generous animals, and their own contentions are still more animated."—The savage ferocity inspired by the frequent repetition of such barbarous exhibitions, accounts in some measure for the conduct of the Ephori of Sparta, who, when they declared war against the Helots, ordered that the young bull-dogs should be employed in

Public sports, consisting in the contests of ferocious animals; which are depraved and barbarous.

* Montesquieu is of opinion, that the want of employment for the majority of the citizens, compelled the Greeks to become a society of athletic and military combatants; for, he observes, "they were not permitted to follow the ordinary occupations of agriculture, commerce, and the baser arts; and they were forbidden to be idle; consequently, their only resource was in the gymnastic and military exercises." But this assertion is contradicted by the practice of some of the Grecian states. We know that in Athens commerce was highly esteemed and successfully cultivated. This writer must therefore be understood in a restrictive and qualified sense, when he says, "Il faut donc regarder les Grecs comme une societé d'athletes & des combattans."—Montesquieu de l'esprit de loix. liv. IV. chap. VIII.

The Pancratium, in which the antagonists voluntarily threw themselves on the ground, and annoyed each other by pinching, biting, scratching, and every kind of savage attack, ought not to be endured in a civilized country.

worrying

worrying these miserable slaves. To the Greeks may be attributed two barbarous diversions, which have been eagerly adopted by succeeding nations. The fighting of cocks, and the diversion of bull-fights. The former was first introduced by Themistocles, as a religious festival:—it soon degenerated into a sport for the gratification of avarice and cruelty. The latter had its rise in Thessaly, and was afterwards transported to Rome by Julius Cæsar*.

Cock fights. Bull fights.

The Roman games carried beyond those of Greece.

To Greece, Rome was indebted for almost every institution of popular sports and bodily exercises;—but the Romans carried them to a height of splendour and magnificence unknown to their first inventors. The Circus and Amphitheatre of Rome, exhibited, on a scale proportioned to the immense extent and power of the nation, all the popular sports † celebrated at the Grecian solemnities. In their gymnasia, youth were likewise carefully instructed in the gymnic exercises, and likewise the athletic combatants trained up for public exhibition:—But the barbarous policy of the state, or rather the rude and ferocious manners of the people, gave rise to the alliance of bloody shews and combats, with manly sports and exercises. A gloomy and ferocious superstition, operating on the minds of a people inured, like the Romans, to foreign warfare and intestine broils, suggested the practice of shedding the blood of captives, as a grateful sacrifice to the *manes* of illustrious warriors. This practice, at first a superstitious rite, became a ceremony of more pomp and ostentation at the obsequies‡ of distinguished persons. Hence the origin amongst the Romans of the profession of a gladiator—and when the

They were more gloomy, ferocious, and cruel.

Combats of gladiators.

* See Pegge's Dissertation on Cock-fighting in the Archœologia Brittan., and Potter's Antiquities of Greece.

† The Ludi circenses, or circensian games, included all the diversions of the Circus, viz. The Pentathlum, or Quinquertium, chariot races, Pyrrhic dance of the Greeks, to which were added sports of Roman origin.—The Naumachia, or sea fights, and bloody combats of gladiators, and the contests of ferocious animals with each other and with man.

‡ The first shew of gladiators was instituted by Marcus and Decius Brutus, on the death of their father, in the year of the city, 490.—See Kennet's Antiquities of Rome.

people

people had once acquired a taste for bloody exhibitions, the detestable spectacle of gladiatorial combats was presented for their amusement.

The progress of cruelty and the danger of gratifying barbarous propensities, cannot admit of more striking illustration than what is afforded by considering the effects of these savage exhibitions on the manners and character of the Romans.

This is not the proper place to discuss the question of *Right* or *Expediency*, which man has always claimed of rendering subservient to his wanton sports, the lives and feelings of the brute creation. It will come with more propriety under discussion in the sequel of these observations.—But it may not be improper, at present, to animadvert on the consequences of rendering bloody scenes familiar and amusing to even an enlightened people.

Conflicts of wild animals with men—

The frequent spectacle of animals* conflicting with each other in the games of the Amphitheatre, gradually hardened the public mind, and begat a necessity for diversions of a more animated and dangerous kind.—Men were encouraged, and even compelled to enter the lists with wild beasts. At first, condemned criminals forfeited their lives in these contests. But these were not sufficiently numerous to gratify the appetite of a degraded and licentious people. Men † were professedly instructed and regularly hired to sell their blood, like gladiators, in these bestial contests. Such enormities, great as they are, hide their diminished heads before the supreme wickedness and cruelty of *gladiatorial* exhibitions. When the susceptibility to humane and tender feelings became almost extinct by the bestial encounters, it became neces-

— first criminals, and afterwards men professionally instructed, &c.

* In the shew of wild beasts exhibited by Julius Cæsar in his third Consulship, twenty elephants were opposed to 500 footmen, and 20 more with turrets on their backs (sixty men being allowed to each turret) engaged with 600 foot and as many horse. There were three sorts of these diversions, under the common title of Venation. The first, when the people were permitted to run after the beasts and catch what they could for their own use—the second, when the beasts fought with one another; and the third, when they were brought out to engage with men.—See Kennet's Roman Antiquities.

† These were called Bestiarii.

sary

sary to gratify their depraved appetites by the exhibition of human butchery and sacrifice. So lost to every spark of decency and humanity were this infatuated and ferocious people, that the highest ranks of society gloried in voluntarily taking a part in these encounters: and even the softer sex, throwing aside every trait of amiable modesty and timidity, were ambitious of displaying their personal courage in these savage contests. This conduct did not escape the lash of the Roman satyrist.

These enormities extended to all ranks, and even to women.

> " Cum ——— Mævia Tuscum,"
> " Figat aprum, & nuda teneat venabula mammâ."

Persons of every age, sex, and condition attended these barbarous sports. The intoxication of the populace, from frequent gratification, arose to such a pitch, that streams of blood flowed annually from several hundreds, perhaps thousands, of the wretched gladiators, throughout the various cities of the empire. When the people had been so far steeped in blood as to prefer beyond any other these sanguinary combats, all the candidates for high offices bribed their favour, by outvying each * other in the number and pomp of these impious shews. Even the most powerful and enlightened minds among the Romans were tainted by the contagious influence of custom and the strength of national prejudice: Cicero, the humane and dignified statesman and philosopher, very faintly, if at all, disapproves of the excessive fondness of the people for this abominable exhibition in his time; and plainly expresses his approbation of the practice as antiently conducted. His words are, "crudele gladiatorum spectaculum & inhumanum nonnullis videri solet; & haud scio an ita sit, ut nunc fit: cum verò sontes ferro depugnabant, auribus fortasse multæ, oculis quidem nulla poterat esse

These habitual cruelties vitiated even the minds of their philosophers.

* Julius Cæsar, in his Edileship, presented three hundred and twenty pair of gladiators—and Trajan, as averse from cruelty as the former, brought out 1000 pair of gladiators during a solemnity of 123 days. But the sanguinary hero enlisted 400 senators and 600 knights (if there be not a corruption of the text of Suetonius, the historian) as gladiators, at a celebration of the Circensian games.—See Gibbon's History of the Decline and Fall of the Roman Empire.

esse fortior contra dolorem & mortem disciplina."—"The shews of gladiators to some persons may seem barbarous and inhuman: and I don't know as the case now stands that the censure is unjust:—But when only guilty persons were the combatants, the ear might receive better instruction—it is impossible, however, that any lesson to the eye can better fortify the mind against the assaults of grief and death." A ridiculous and inhuman assertion (an eloquent historian exclaims) admirably confuted by the bravery of antient Greece and modern Europe.

Absurd and inhuman argument.

Indeed so little was the practice connected with military ardour and true courage, that before its establishment the Romans were, perhaps, more distinguished for bravery, steadiness of discipline, and contempt of death, than at any subsequent period of their history.

The Romans did not improve in military spirit;—

It is, however, certain, that in proportion to the frequency and extent of these bloody exhibitions, did the military valour and discipline of the Romans sink into a state of degradation and contempt. "After subsisting a period of 600 years" (according to the remark of Gibbon), "Honorius gave the final blow to this inveterate abuse, which degraded a civilized nation below the condition of savage cannibals."

— but became degraded in these times of cruelty.

Rome justly suffered moral and political evils from fostering such inhuman propensities: her existence was more than once at stake by the insurrection of the wretched and despairing victims of her barbarity. Besides, the corruption of the populace, through the medium of these diversions, was no difficult task to the powerful and wealthy. When man has been taught to subdue the humane feelings of his nature, he contracts an indifference to the purer and nobler virtues which fit him for discharging the duties of a good citizen. Indeed every habit that wears out the sympathizing sensibility of the heart, proportionably disqualifies man from exercising the pleasing duties and tender charities, connected with public and domestic life.

Danger of insurrection.

It would appear from this hasty sketch that the popular games and exercises of the Greeks when compared with those of the Romans, were better calculated to promote the social as well as individual welfare of mankind.

The Grecian sports had good effects; the Roman, the contrary.

The Grecian sports fortified the body and disciplined the mind, without injuring the one or brutalizing the other.

Universal depravity accompanied the latter;

Indeed the superior wisdom of Grecian policy rendered the public diversions subservient to the interests of the state as well as to the happiness of the people. The Roman government did not always neglect this branch of policy. For, their sports, in the early and rude state of the nation, were adapted to the circumstances in which the people were placed. But incessantly harassed themselves, or employed in harassing others, they had neither leisure nor inclination to cultivate those arts which contribute to liberal amusement: ever occupied with warfare, all their amusements had a warlike tendency. The contests of savage animals and the conflicts of gladiators, suited alike the ferocious manners of the populace and the political views of their rulers. When the empire had subdued more polished nations, it might have been expected, that its amusements would have assumed a different spirit and complexion. But the habits of the people were too deeply rooted and depraved to be easily changed—And, indeed, so far were their rulers from wishing to accomplish this reformation, that, from corrupt and selfish views, they studiously excited the propensities of the people toward degrading and inhuman shews, by administering constant food for these savage enjoyments.

— which was not changed by intercourse with more polished nations.

Modern civilization has bettered the condition and manners of society;

In the progress of civilization, since the downfal of the Roman empire, great and important changes have taken place in Europe, with respect to religious, political, and civil institutions. The melioration of the condition of man in his social and domestic state, and the general refinement of his character and manners, have been the happy result of these moral and political revolutions.

— but barbarity still remains;

Yet still there remain sufficient vestiges of antient barbarity to throw a dark shade on the present state of improved civilization. The cruel sports still so highly relished in many parts of modern Europe, and which bear so near a resemblance to the savage contests of the Circus, exhibit lasting and disgraceful proofs of the relics of antient barbarism. Our own country has been but too justly stigmatized, even by her less polished neighbours, for

for the devotion of the lower ranks of the people to those amusements which are derived from the sufferings of the brute creation.

Although the resemblance (whether it be original or imitative is of little importance) between the cruel diversions of England and of Rome, may be considered a subject of just regret; yet the similarity in some of the manly exercises and hardy sports, practised by the two nations, cannot but claim our warm and just admiration.

Especially amongst us; but they are mostly athletic.

If we have retained more of the barbarous sports of antiquity than the rest of Europe, there is the merit due to us of having more extensively adopted and practised those amusements and exercises, which inure the body to labour and fatigue, and inspire the mind with courage and emulation. In treating on the general character and spirit of some of the sports and exercises of the people of England, it will not be necessary to enter into particular detail. It is only proposed to hint at those of a popular nature, and which seem to be interwoven with the customs and manners of the mass of the people. They may be comprised under two heads.

1st. The sports which are derived from the animal creation.

2d. The amusements which depend upon bodily exercises and personal contests.

British sports, contests of animals.

I. It cannot be denied, that mankind, at every period of society and under every diversity of country and government, have rendered the animal race subservient to their wanton and cruel sports. But the universality and antiquity of a practice, founded on inhumanity and impolicy, are inadequate to sanction its utility and continuance. If it can be shewn that barbarous sports tend to brutalize the human character, and are inconsistent with the manifest intentions of Providence; the argument derived from long custom and authority must fall to the ground. There is a sympathy implanted in our natures, which renders us feelingly alive to the pains and pleasures of our fellow-creatures, and is even extended to every part of the animal creation. Upon the due exercise of this principle depends great part of our social and individual happiness.—Whatever then has a tendency to

Cruelty to animals will destroy the general sympathy of man;

diminish the influence of this principle, ought carefully to be avoided. Now every single act of cruelty contributes its share toward the weakening or extinguishing the principle of sympathy; and by the repetition of such acts, according to the general laws of habit*, a disposition to cruelty is likely to be generated. If a child be early indulged in sportively tormenting *animals*, and this vicious propensity be suffered to grow up into a habit, his sensibility to *human* suffering will be proportionably diminished; insensibility will harden into brutality; and at length he will not be restrained from positive acts of cruelty toward his own species, whenever goaded by

— and render him callous to every proper feeling in society.

the feelings of interest or of passion. Hogarth, our great moral painter, has admirably illustrated the progress of cruelty in the human breast. The first stage of his hero's career is marked by sportive and wanton barbarity to animals. Upon this foundation crimes are soon erected; and at length grown callous to every social † and moral feeling, he closes his profligate career, by the perpetration of a deliberate and cruel murder. Another excellent

Illustrations by Hogarth and Dr. Moore.

judge of the human heart, Dr. Moore, has forcibly depicted the effects of wanton cruelty to the inferior crea-

* "The habitude which the people of this country (viz. Cape of Good Hope) necessarily acquire in witnessing instances of cruelty on human as well as brute creatures, cannot fail to produce a tendency to hardness of heart, and to stifle feelings of tenderness and benevolence. In fact, the rigour of justice is seldom softened with the balm of mercy."—See Barrow's Travels in Africa, Vol. II. p. 41.

† Such is the general impression on the mind of the power of habit to generate cruelty, that in most countries, those occupations which employ men in the destruction of animal life for the sustenance of human kind, are held in degradation and contempt. The lowest of the butchering tribe, in default of an executioner, is compelled to perform his functions in France and many other parts of the continent. There is an opinion prevailing in England, that butchers, and even surgeons, are equally disqualified, by the nature of their occupations, to sit upon juries, in trials affecting the lives of their fellow-subjects. This is probably a popular error; or, if true, yet a much more honourable reason may be assigned, why surgeons are not required to act in the capacity of jurors. Their office is to administer to the sufferings and calamities of their fellow-creatures—and it is fit they should every moment be disengaged and free to obey the summons to so humane a duty.

tion,

tion, in the character of Zeluco. The feelings of humanity became stifled in this monster's breast, from an early gratification of his caprice and passion in sporting with the torments of the animal race. It is likewise our duty as well as moral advantage—to refrain from all acts of wanton cruelty to the brute creation. The organs of sensation in all the inferior animals, are evidently adapted for receiving and transmitting impressions of pain and pleasure,—and although deprived of speech, their groans and cries are intelligible indications of their painful feelings. Nor are animals less capable of expressing signs of pleasure, as well as of suffering. This provision for the gratification of their several senses, is a sufficient proof of the intentions of the Creator. Like man, they were formed to feel and to enjoy. Here rests the foundation of their natural right to protection and humane treatment from mankind.

The system of nature requires that animals should be destroyed;

It cannot be inferred from this mode of reasoning, that animal life should in every instance be held sacred. The laws of nature and necessity demand from us the painful sacrifice.—Man must destroy life in order to live. Besides, we must consider that if man had subsisted only on vegetable food, the majority of the animal race which furnish his table would never have enjoyed life. Instead of increasing the breed of animals, he would have been compelled to destroy them to prevent a famine.—But barbarously, wantonly and deliberately, to torture and destroy animal life, is equally repugnant to humanity, duty and the best interests of mankind. Experience teaches us, that the common sense and feeling of mankind, condemn that man whose greatest delight seems to consist in bloody and barbarous sports.—Youth, it must be observed, commonly inflict pain on animals in mere sport without a due knowledge of the evil they commit. And the ignorant populace frequently err from the same cause. They are led to consider, but too often, from the connivance and even encouragement of their superiors in knowledge and station, that the animal race are equally indifferent to pleasure or pain; and only created for the purpose of gratifying the appetite, or contributing to the diversion of mankind.

—but not with the wanton infliction of torture.

If

Question. Whether all sufferings inflicted by man or animals are to be condemned?

If the question be asked,—" Whether all sports derived from animal suffering be entitled to equal condemnation?" The answer is decidedly in the negative.—For, although perhaps none can be completely justified, yet there is still a wide difference in the degree of moral and physical evil resulting from their practice. That class of diversions pursued for the benefit of health and exercise, where the enjoyment of pleasure springs from the exertion of our active faculties, must not be compared with those depraved and cruel sports, which merely consist in the torture and destruction of the animal. In the present state of society, active diversions become almost necessary to the well being of the opulent and sedentary classes of mankind. Man cannot be happy without occasional active employment. He pines in the lap of ease and pleasure, and requires the stimulus of animated exertion.—Hunting in all stages of society has therefore formed a principal share of the business and pleasure of man. But in this kingdom especially, a considerable portion of its inhabitants devote part of their time to the active and vigorous pursuits of the chace. And although it may be urged in favour of this exercise, that it invigorates the spirits, teaches men to despise enervating pleasure, and inures them patiently to sustain hunger, cold and fatigue; yet it cannot be denied, that it has a tendency, when too eagerly pursued, to blunt the sensibility,—to render the manners rude and coarse, and thus to degrade the dignity of the human character. The man of enlarged understanding, liberal notions and elegant manners, may occasionally call in the aid of the chace to relieve the fatigue of sedentary employment, or renovate the powers of nature, exhausted by mental exertion, without much apparent injury to his manners or morals;—but *frequently* to take pleasure in that, by which misery to animals is inflicted, if not absolutely vicious, is yet of no good tendency; it conduces neither to form the gentleman nor the man.

Apology for hunting.

If it be considered as too nice and fastidious a delicacy to impute blame to the practice of destroying animals for the purpose of health, exercise and recreation, it may, however, be allowed to call in question the policy and

humanity

humanity of other diversions, once highly cherished, and still too much practised by the people of this country. Some of these national sports are sanctioned by the practice and encouragement of many persons distinguished for rank and talents.—That there should be found such abettors of the bloody and barbarous diversions of *cock-fighting* and *bull-baiting,* is both a subject for surprise and regret.—These two amusements seem to have survived the destruction of many other sports equally as unmeaning and barbarous; but that they should not have entirely yielded to the improved state of manners—or the interference of the laws, is a subject of just reproach to us by foreigners, and of deserved reprobation by the humane and reflecting of our own countrymen. The reciprocal influence of sports and manners on each other, may be shown from these and similar diversions, as practised in various periods of our history. A late ingenious and laborious writer* has described the ancient and modern diversions of the people of Great Britain, from the earliest authentic records to the present time.—This picture confirms the general truth of the position:—That as a nation improves in manners and civilization, it loses its high relish for inhuman and ferocious diversions. It is more than probable, that the sports derived from animal contests, such as bull-baiting, bear-baiting, and cock-fighting, are vestiges of Roman amusements introduced by that people into this conquered island. It is at least certain they were practised † in the early period of

Cock-fighting and bull-baiting condemned

* See Strutt's Diversions and Pastimes of the People of England.

† The jongleurs or jugglers, in the reign of Henry the 2d, made a profession of training bulls, bears, and even horses, for the purpose of baiting them with dogs.—The sport of fighting cocks in pitched battles, first appears on record in the same reign. During subsequent reigns this sport became general; and to the disgrace of our country was countenanced by royal favour during James the 1st and Charles the 2nd's reign. If the Romans set us the example in devising these sports, it must be confessed, we have "bettered the instruction." For to English refinement and ingenuity may be ascribed the noble invention of the Gaffle or Spur; by the aid of which, the gallant combatants of the cockpit mangle, torture and destroy each other; no doubt to the great satisfaction and delight of

of our history. During the military enthusiasm of the middle ages, while jousts and tournaments furnished amusement to the nobility and gentry, martial exercises constituted the chief diversions of the body of the people.

Science of defence. Prize fighters or English gladiators.

Hence arose the establishment of schools for teaching the "Noble science of defence," as it was called. These laid the foundation for professed gladiators, or prize-fighters.—The great prevalence of murder, robbing and every species of barbarity, in consequence of these proceedings, during the reign of Edward the First, compelled the government to issue an edict to suppress the schools as well the combats of prize-fighters.

During the reign of Henry the Seventh and Henry Eighth, these schools were revived in consequence of a supposed degeneracy in the military spirit of the people; and the baiting of animals at the same time became a favourite * diversion.

The bear garden.

The Bear-garden †, during the 16th and the early part of the 17th century, was the place of rendezvous for the highest as well as the lowest classes of society. The Tatler, when treating on the barbarous sports of this national circus, and tbe comments of foreigners on the subject,

of admiring spectators. Another instance of our barbarous ingenuity must not be omitted. No other nation but the British has contrived to put in practice the *Battle-Royal*, and the *Welch-Main*.—In the former, the spectator may be gratified with the display of numbers of game-cocks, destroying each other at the same moment without order or distinction. In the latter, these courageous birds are doomed to destruction in a more regular, but not less certain manner. They fight in pairs, (suppose 16 in number) and the two last survivors are then matched against each other; so that out of 32 birds, 31 must be necessarily slaughtered.—See Pegge's Essay on the Archœlogia Britannica.

* Stephen Gossen, in the latter end of Henry 8th's reign, considers that our ancestors had entirely sunk into the lap of effeminacy, as may be proved by the following singularly quaint and alliterative style of abuse. "Our wrestling at arms is turned into wallowing in ladies' laps; our courage to cowardice; our running to riot; our bows into bowls; and our darts into dishes.

† Another common diversion, during the period of Queen Elizabeth and in the two following reigns, consisted in several persons at the same time scourging with whips, a blind-folded bear round the ring, whose sufferings and awkward attempts at revenge highly gratified the noble, as well as ignoble spectators.

adds,

adds, "I wish I knew how to answer the reproaches which are cast upon us, and to excuse the death of so many innocent cocks, dogs, bulls and bears, as have been set together by the ears, and died an untimely death only to create us sport." Bull-baiting was not confined within the limits of a bear-garden, but was universally practised on various occasions, in all the towns and villages throughout the kingdom. In many places the practice was sanctioned by law, and the bull-rings affixed to large stones driven into the earth remain to this day, as memorials of this legalized species of barbarity. The regular system of bull-baiting seems to have commenced with the reign of King John. Its general prevalence since that period, until within a few years, must have produced important effects on the manners and character of the people. The misery it has inflicted on the harmless and inoffensive brute, is a matter of no small regret and indignation with the humame and considerate part of mankind;—but the injury done to public morals and social huppiness, by an attachment to this degrading pastime, is still more to be deplored. Numbers of bulls were, and still continue to be, regularly trained and carried about from village to village, to enter the lists against dogs bred up for the purpose of the combat. To detail all the barbarities committed in these encounters would be a disgusting and tedious task. All the bad passions which spring up in ignorant and depraved minds are here set afloat. The torments and blood of the suffering beast, are purchased by money of his unfeeling master; and the owners of the dogs are not more gratified in gaining their sanguinary wagers, than in applauding the savage ferocity displayed by these animals. We cannot often appeal to the annals of bull-baiting;—but if they were regularly laid open, it is probable that many instances of a similar kind to the following might be held up as a lesson to the abettors of such diversions.—* "Some years ago at a bull-baiting in the North, a young man, confident of the courage of his dog, laid some trifling wager, that he would at separate times cut off all the four feet of his dog, and that after

Bull-baiting still continues

to degrade the public morals and disgrace the nation.

Detestable barbarities practised by the followers of this sport.

* See Bewick's Quadrupeds.—Article Dog.

every amputation he would attack the bull. The cruel experiment was tried, and with success." Such detestable barbarity can only be exceeded by the following recital extracted from the public prints of 1799. At a bull-baiting in Staffordshire, after the animal had been baited by single dogs, he was attacked by numbers let loose at once upon him.—Having escaped from his tormentors, they again fastened him to the ring; and with a view either of gratifying their savage revenge, or of better securing their victim, they actually cut off his hoofs, and enjoyed the spectacle of his being worried to death on his bloody and mangled stumps. These facts speak more than a volume against the sophistic arguments of the advocates for exciting brave and manly courage by the exhibition of bloody and barbarous sports.

[To be concluded in our next.]

VII.

Remarkable Effect of the Effluvia from Ammonia Muriate of Platina on the Eyes, Nostrils, Throat, and Lungs, as in a Catarrh. In a Letter from An Occasional Correspondent.

To Mr. NICHOLSON.

SIR,

Effects not hitherto noticed

I DO not know that the following effects of the effluvia of precipitate of platina by muriate of ammonia, i. e. of ammonia muriate of platina, have been observed; and whether or no these are like those from the effluvia of ipecacuanha, in occasion, as asthmatical paroxysms, only to be considered as produced in particular constitutions, I must learn from the intelligent correspondence of your journal.

--on the system, by vapour from ammonia muriate of platina.

Every time I have had occasion to open a paper, or small parcel of the above precipitate, although I merely touched it with my fingers, or even when I did not touch it, but merely inspected it for a minute or two, I was in a few

few minutes affected with an uneasy sensation in my eyes, nostrils, throat and lungs, exacting a discharge of tears, sneezing, with running from the nose as in a catarrh, shortness of breath, attended by an itching and heat of the face with sometimes redness of it as from erythema. The last time I was affected, although I had not touched the precipitate, I experienced along with the above effects a slight disagreeable taste, and the dyspnœa continued after the catarrhal symptoms had vanished; which they do usually in about an hour. It may be proper just to mention also, that after leaving my laboratory for about two hours after the above effects came on, and by which time I was nearly recovered, as soon as I returned to the place where I opened the parcel, but did not again expose myself to it, the above symptoms were again brought on, although in a slight degree. I found wetting my face with cold water very serviceable in removing the erythema, and removing of course the heat.

I take for granted it is commonly known that by a similar exposure to the powder of ipecacuanha root, a fit of asthma is brought on in particular persons, although so rarely that such persons are considered to have what is called idiosyncrasy of constitution.

The diffusion through the air, manifested in the above cases of invisible and imponderable particles of matter, may serve to enable us to conceive the mode in which infectious matters are communicated.

I am,
Dear Sir,
With much regard,
An Occasional Correspondent.

Oct. 10th, 1806.

VIII.

Extract from a Letter of M. Proust, to M. Vauquelin, on Porcelain and on the Alimentary Use of Lichen Islandicus.*

Madrid, *Dec.* 22, 1805.

Sir,

Excellent pottery made from spuma maris.

I was visited by one of your pupils, M. Siquiera, an interesting and intelligent Portuguese young gentleman. We are going, to-morrow, to see the manufacture of porcelain under the direction of M. Sureda, who was brought up to this art in the manufactory of Sevres, and now makes a most beautiful porcelain, of a much harder texture than yours. This is not effected by means of kaolin, but with the *spuma maris*, a *siliceous magnesian stone*, found in the neighbourhood of Madrid; we shall send you some patterns which will astonish you. He covers his biscuit with feldspaths of Gallicia, which are very beautiful. The stone above mentioned would be excellent for the construction of chemical furnaces. When taken from the quarry, it is soft and admits of being cut like soap. Furnaces made of this stone are extremely light, and never undergo fusion, however intense the heat may be. Were such a fossil to be met with near Paris, we might do without the *rue mazarine*, (qu?). Besides magnesia, silex, and some particles of argil and lime, this stone contains a portion of potash, which contributes, not a little, to the superior qualities of the porcelain.

Lichen Islandicus; its value as food.

The following fact is perhaps no less interesting than that above alluded to. Don Mariano la Gasca, pupil of Cavanillez, a young botanist of great promise, has just presented me with a specimen of Lichen *(Islandicus)* which he has discovered in the mountains of Leon, where it grows plentifully.

I expected to find in it merely a weaker or stronger tinctorial matter; but I find when properly boiled it is very good to eat, is very tender, and, I think ought to be considered

* Annales de Chimie, Vol. LVII. p. 196.—February 1806.

sidered a resource for food provided by Nature perhaps in every country, which has hitherto been overlooked. I would recommend you to draw the attention of the botanists at Paris towards this plant, and provide some yourself for the entertainment of your friends; it is an excellent culinary vegetable. I think I once saw some at Vincennes or in the *Bois de Boulogne*.

One pound of this Lichen, dry, produced three pounds when dressed and well drained: it may be eaten with oil, butter, and no doubt in many other ways. We have already had it six times on our table, and my friends were much pleased with it. Its texture is purely membranaceous, containing neither wood nor filaments, which renders it a very agreeable food. It may be reasonably expected, that in so numerous a family, other species may be found equally nourishing, and perhaps more so. Although very elastic after being dressed, it contains not the least animal matter; for its products are similar to those of sugar, which has surprised me. A pound of this Lichen will make eight pounds of soup, which in cooling, turns to jelly, like that made from animal food. It is slightly bitter, but not more so than weak chicory water. I seasoned some with sweet and bitter almonds, lemon peel, and sugar, and it made me a very nutritious and agreeable dish. The mucilage of this plant is gelatinous, very different from gum; it appears to me to resemble that obtained from fruits. I am going to examine it in other respects, and to ascertain whether this plant affords any colouring matter for dying processes. At all events it appears that Nature cannot furnish a more excellent article of food than this vegetable.

Particular account of the good qualities of the Lichen.

IX.

On the Means of preserving Water in long Sea Voyages, and the application of the same Means for keeping Wines. By M. L. G.*

MR. BERTHOLLET in the year 1803 communicated to the Class of Mathematical and Physical Science of the National

Proposal by Berthollet to carbonize or char the inside of casks.

* Annales de Chimie, LIX. p 96.

National Institute of France, the result of an experiment on the property of charcoal to preserve water. He had four months before that time filled with water two casks, one of which had its internal surface burned. The water it contained proved fit for use, and without any bad flavour; while that in the other cask, which had not been so prepared, was so much corrupted that the smell was intolerable.

Successfully carried into effect at Sea

The Court Gazette of Petersburgh, of May 30 last, contains an account of the success which this process was attended with in the ship of Captain Krusenstern.

He writes from Kamschatka, the 8th July 1805, to Mr. Schubert, of Petersburgh, that during his stay at Copenhagen a journal * fell into his hands, in which this process is indicated by a French chemist; that he immediately caused the internal surface of 50 or 60 casks to be burned within in a much more effectual manner than is usually done in ships of war, where the charring being only slight, the advantages are also very trifling.

by Mr. Krusenstern.

During his stay at the Brazils, Mr. Krusenstern also caused the greatest part of his casks to be burned inside; and during the whole of his passage as far as the Isle of Washington, the water in these casks was constantly found to be good. In order to maintain the cleanliness

* This journal is probably that of M. M. Pfaff and Friedlander, which was printed at Leipzic under the title of *Die neuesten entdeckungen Fransosischer gelehrten, &c.* It contains, in the Number for May 1803, an extract of the memoir of Berthollet on this subject; the author of that article thinks he recollects that Lord Macartney had before used powdered charcoal in his provision of water for his voyage to China; but this does not take away the priority of carbonizing the inner surface of the casks.—Note of the Author.

The author proceeds to express his doubts whether charcoal was really used for this purpose in that voyage, but I have thought it needless to translate his remarks, because it is certain that Lowitz, to whom the merit of the first discoveries of the active power of charcoal in purifying and otherwise changing a great number of bodies, did very early apply it to the purifying and preserving natural waters. See three volumes of Memoirs translated from Crell's Journal, and published in London in 1793, by Baldwin. The process of clarifying muddy water by a very minute addition of alum, which is mentioned in the same voyage as practised in China, has been long known, and in common use here.—N.

of

of these casks, he preferred the inconvenience of having his ballastage to attend to rather than fill them up with sea water, as is usual, when they were empty, which tends to hasten the corruption of the fresh water that may be afterwards put into them. On his arrival at Japan, he burned as strongly as possible every one of his water-casks, and the success of this practice was still more evident during a passage of seven weeks from thence to Kamschatka.

"Our water," says he, "was constantly pure, and as "good as that from the best springs; so that we have "had the honor of being the first to carry so simple and "so useful a practice into effect; and the French Che-"mist will perhaps receive some satisfaction from hear-"ing of our happy success."

The water at sea was as tasteless as spring water.

The preceding notice is followed by an address on the part of one of the Editors of the Annales de Chimie to Mr. Berthollet, in farther explanation of the subject. He remarks, that

The coating of charcoal acts in two manners; 1. It opposes the solution of the extractive part of the wood. 2. It prevents the putrefaction of that which may have been dissolved from such parts of the wood as might not have been originally well charred, or from which the coal may have been detached.

If the charcoal were merely to be put into the cask, or the putrefaction were corrected by means of filters containing charcoal powder, the first effect would not be obtained; and the second would even cease to be produced as soon as the property of the charcoal should be exhausted.

The process for carbonizing the inner surface of casks may also afford advantages for the preservation of wines.

The same process promises to be of value in casks for wine.

Wine, as well as water, must dissolve the extractive part of wood; and its taste, particularly when it has not one which predominates, must by that means be altered. This is the reason why casks which have already been much used are preferable to those which are new.

2. This extractive part probably favours the acid fermentation, which easily takes place in sea voyages in consequence of agitation and an elevated temperature. Hence it

it is that many kinds of wine cannot be conveyed by sea or to great distances.

Wine sufficiently clarified becomes perfect in bottles. Does not this arise from its being preserved from the extractive part of wood? and may we not conjecture that it would become still more agreeable if preserved in casks charred within, and which on that account might be substituted instead of stone ware, or good glass, besides possessing that large capacity which is favourable to the last fermentation, which renders its qualities perfect?

General view of the subject.

Spirituous liquors likewise dissolve the extractive part of wood, and receive qualities which are in some cases valued, but in others detrimental. The charred casks would prevent this effect. In a word, the casks which have received this preparation may be used for all the purposes in which liquids are to be preserved, without being affected by the extractive part of wood, and they prevent the putrefaction to which some of them may be subject.

These views are perhaps carried too far, and may require to be supported by experience. The observations here given may serve to direct the proceeding for this purpose, which cannot but be interesting to chemists as well as others.

X.

A Chemical Examination of the Hepatic Ore of Mercury from Idria. By M. Klaproth.

Analysis of the hepatic ore of Mercury.

THE compact hepatic Mercury employed in this analysis, is of a colour which holds a middle rank between a deep cochineal red and the grey of lead; it is almost always found in compact masses. The faces of contact are brilliant. It exhibits a very slight metallic lustre in its fracture; is opake; its powder is of a deep brown red; and the scraped part shines a little. It is tender, not brittle, and has a specific gravity of 7, 1.

The polish it takes is bad, and in this state it appears

pears of a clear liver-coloured brown, whence it has its name.

Analysis of the hepatic ore of Mercury.

A. 1000 grains of this ore, distilled with half its weight of iron filings, afforded 818 grains of pure mercury, the residue consisted of sulphuret of iron mixed with a black powder, soiling the fingers like soot.

B. a. 100 grains reduced to fine powder were heated in 500 grains of muriatic acid to ebullition.

Sulphurated hidrogen gas was disengaged. The mineral was decomposed by adding, a little at a time, 100 grains of nitric acid; a black residue of ten grains remained. This residue was burned in a porcelain capsule very carefully, in order that the sulphur only might be burned. There remained three grains of a light coaly powder, which became ignited and burned by a stronger heat, leaving one grain of reddish ashes.

b. The solution was precipitated by the muriate of barytes. The sulphate of barytes, which was obtained after having been made red hot, weighed 46,5 grains; so that there were 6,5 grains of sulphur converted into sulphuric acid by the action of the nitric acid. Estimating the quantity of sulphur contained in the sulphurated hidrogenous gas at 0,25 grains, we have 13,75 parts of sulphur in 100 of the mineral.

C. a. 1000 grains of hepatic mercury in powder were put into a retort adapted to the pneumatic apparatus; the heat was gradually raised till the residue became red hot. After the first heat had driven out the atmospheric air, sulphurated hidrogen gas issued forth, which burned with a blue flame; its volume was 24 cubic inches, without reckoning that which had been absorbed by the water put into the intermediate receiver, which was strongly impregnated with it.

b. A few globules of mercury were collected in the receiver. In the neck of the retort was a mixture of Ethiops mineral of a greasy looking humidity, some small metallic globules, and a few small needles of cinnabar. The mercury which was mechanically extracted from this mixture weighed 3,17 grains. The posterior part of the neck of the retort was alone covered with a solid

Analysis of the hepatic ore of Mercury.

solid sublimate of pure cinnabar which weighed 2,56 grains.

c. The residue appeared in the form of a coaly powder resembling soot, and weighed 39 grains. When burned in the open air in a roasting test, it left 16 grains of ashes; so that the carbon consumed amounted to 23 grains.

d. The earthy residue was digested with muriatic acid. Silex remained at the bottom, which after ignition weighed 6,5 grains.

e. The muriatic solution, which was of a yellow colour inclining to light green, was supersaturated with ammonia; a brown viscid precipitate fell down, and the fluid assumed a light blue tinge. The precipitate when dissolved in an hot alkaline lixivium left the oxide of iron, which was attracted by the magnet after having been ignited, and weighed 2 grains.

f. Muriate of ammonia was poured into the alkaline fluid, and threw down alumine, which after ignition weighed $5\frac{1}{2}$ grains.

g. The other ammoniacal fluid was supersaturated with muriatic acid. A bar of zinc immersed therein separated 0,20 grains of metallic copper.

On collecting the results of this analysis of the hepatic ore of Idria we find that 1000 parts consist of

Mercury................	818	
Sulphur	137	50
Charcoal................	23	
Silex....................	6	50
Alumine	5	50
Oxyde of Copper	2,	
Copper	0	20
Water which served to form the sulphurated hidrogen gas, and other loss......	7	30
	1000	

This analysis may serve to rectify the false notions which have been adopted concerning the composition of this

this mixed mineral. By shewing that the sulphur is combined with the metal in the same proportion as in cinnabar, namely as 1 to 6 in round numbers, we are taught how little foundation there is for the opinion of those who, like Sage and Kirwan, think that a part only of the mercury is in the state of sulphurated mercury, and that the other is in the state of a simple oxide. If that were the case, the non-sulphurated part would certainly be soluble in the nitric acid. Experiment shews that this is not the case, because the acid cannot dissolve any part, even when boiling, the mineral powder remaining unchanged at the bottom of the vessel. This opinion has perhaps been taken up from observing that in sublimation a part only of the mineral rises in the state of cinnabar, while the other passes in the form of fluid mercury. But this arises from the presence of charcoal among its ingredients, which decomposes cinnabar at an elevated temperature: whether it be that the carbon takes from the mercury the minimum of oxygen necessary to the formation of cinnabar, or whether it be that the sulphur which combines at an high temperature with the carbon, and forms carbonated sulphur, is put into a state in which it cannot combine chemically with the mercury. The facts shew that it is really so; for having as a direct proof sublimed artificial cinnabar with lamp black, the greatest part of the cinnabar was decomposed in the same manner as the hepatic mercury, and the result was a mixture of Ethiops mineral and globules of metallic mercury.

Analysis of the hepatic ore of Mercury.

As an observation on the state in which mercury exists in cinnabar, I shall add that the antient opinion that it has the state of a perfect oxide cannot be maintained from the proofs which have been given by Proust, Bucholz, and others.

But does cinnabar absolutely contain no oxigen? and is the mercury in the metallic state? For my part, I think the question requires to be examined more exactly. From the appearances it seems that the mercury must exist in cinnabar at a very low degree of oxidation; which on that account has not yet been examined by observers. On this question, respecting which the pre-

sent limits do not permit me to say more, it must be observed, 1. that in cinnabar, whether natural or artificial, the metallic base, like all the other metals, at their lowest degree of oxidation, resists solution in the nitric acid; 2. that in the fabrication of cinnabar in the dry way, is always accompanied with an inflammation which appears to me to be an oxidation.

XI.

On the Quantity and Velocity of the Solar Motion. By WILLIAM HERSCHEL, *L.L. D. F. R. S. From the Philosophical Transactions for* 1806.

Investigation of the proper motion of the sun.

THE direction of the solar motion having been sufficiently ascertained in the first part of this paper*, we shall now resume the subject, and proceed to an inquiry about its velocity.

The proper motions, when reduced to one direction, have been called quantities, to distinguish them from the velocities required in the moving stars to produce those motions. It will be necessary to keep up the same distinction with respect to the velocity of the solar motion; for till we are better acquainted with the parallax of the earth's orbit, we can only come to a knowledge of the extent of the arch which this motion would be seen to describe in a given time, when seen from a star of the first magnitude placed at right angles to the motion. There is, however, a considerable difference between the velocity of the solar motion and that of a star; for at a given distance, when the quantity of the solar motion is known, its velocity will also be known, and every approximation towards a knowledge of the distance of a star of the first magnitude will be an approximation towards the knowledge of the real solar velocity; but with a star it will be otherwise; for though the situation of the plane in which it moves is given, the angle of the direction of

* Phil. Trans. for 1805, page 231; or see our Journal, Vol. XIII. p. 59.

of its motion with the visual ray will still remain unknown.

Investigation of the proper motion of the sun.

As hitherto we have consulted only those proper motions which have a marked tendency to a parallactic centre, we ought now, when the question is to determine the velocity of the solar motion, to have in view the real motion of every star whose apparent motion we know; for as it would not be proper to assign a motion to the sun, either much greater or much less than any real motion which may be found to exist in some star or other, it follows that a general review of proper motions ought to be made before we can impartially fix on the solar velocity; but as trials with a number of stars would be attended with considerable inconvenience, I shall use only our former six in laying down the method that will be followed with all the rest.

Proportional Distance of the Stars.

We are now come to a point no less difficult than essential to be determined. Neither the parallactic nor real motion of a star can be ascertained till its relative distance is fixed upon. In attempting to do this it will not be satisfactory to divide the stars into a few magnitudes, and suppose *these* to represent the relative distances we require. There are not perhaps among all the stars of the heavens any two that are exactly at the same distance from us; much less can we admit that the stars which we call of the first magnitude are equally distant from the sun. And indeed, if the brightness of the stars is admitted as a criterion by which we are to arrange them, it is perfectly evident that all those of the first magnitude must differ as much in distance as they certainly do in lustre; yet imperfect as this may be, it is at present the only rule we have to go by.

The relative brightness of our six stars, may be expressed as follows: Sirius - - - Arcturus - Capella ; Lyra - - Aldebaran , Procyon.

The notations here used are those which have been explained in my first Catalogue of the relative Brightness of the Stars*; but to denominate the magnitudes of these six

* Phil. Trans. for 1796, page 189.

stars,

Investigation of the proper motion of the sun.

stars, so that they may with some probability represent the distances at which we should place them according to their relative brightness, I must introduce a more minute subdivision than has been commonly admitted, by using fractional distinctions, and propose the following arrangement.

Table VIII.

Proportional Distances of Stars.

Sirius	1,00	Lyra	1,30
Arcturus	1,20	Aldebaran	1,40
Capella	1,25	Procyon	1,40

The interval between Sirius and Arcturus is here made very considerable; but whoever will attentively compare together the lustre of these two stars, when they are at an equal altitude, must allow that the difference in their brightness is fully sufficient to justify the above arrangement.

The order of the other four stars is partly a consequence of the distance at which Arcturus is placed, and of the comparative lustre of these stars such as it has been estimated by observations. But if it should hereafter appear that other more exact estimations ought to be substituted for them, the method I have pursued will equally stand good with such alterations. I have tried all the known, and many new ways of measuring the comparative light of the stars, and though I have not yet found one that will give a satisfactory result, it may still be possible to discover some method of mensuration preferable to the foregoing estimations, which are only the result of repeated and accurate comparisons by the eye. Whenever we are furnished with more authentic data the calculations may then be repeated with improved accuracy.

Effect of the Increase and Decrease of the Solar Motion, and Conditions to be observed in the Investigation of its Quantity.

The following table, in which the 2d, 4th, and 5th columns contain the sides of the parallactic triangle, is calculated with a view to show that an increase or decrease of

Investigation of the proper motion of the sun.

of the solar motion will have a contrary effect upon the required real motions of different stars; and as we are to regulate the solar velocity by these real motions, an attention to this circumstance will point out the stars which are to be selected for our purpose.

Table IX.

Stars and relative Distances.	Apparent Motion.	Solar Motion.	Parallactic Motion.	Real Motion.	Velocities.
Sirius 1,00	1″,11528	1,0	″ 0,67768	+ ″ 0,46518	465175
		1,5	1,01652	+ 0,21701	217007
		2,0	1,35536	— 0,32776	327755
Arcturus 1,20	2″,08718	1,0	0,53579	+ 1,57389	1888670
		1,5	0,80368	+ 1,30478	1565735
		2,0	1,07158	+ 1,01561	1218736
Capella 1,25	0″,46374	1,0	0,79593	— 0,42159	526987
		1,5	1,19390	— 0,79637	995465
		2,0	1,59186	— 1,18662	1483270
Lyra 1,30	0″,32435	1,0	0,32542	— 0,47065	611839
		1,5	0,48812	— 0,59923	778995
		2,0	0,65083	— 0,74135	963750
Aldebaran 1,40	0″,12341	1,0	0,65117	— 0,53208	744913
		1,5	0,97676	— 0,8 737	1200324
		2,0	1,30234	— 1,1 283	1655967
Procyon 1,40	1″,23941	1,0	0,66394	+ 0,59548	833665
		1,5	0,99591	+ 0,30731	430227
		2,0	1,32788	— 0,23385	327390

The real motion of Arcturus contained in the 5th column compared with that of Aldebaran, shows that when the solar motion is increased from 1,0 to 1,5 and to 2″,0 the real motion of Arcturus will be gradually diminished from 1,57 to 1,30 and to 1″,02, while that of Aldebaran undergoes a contrary change from 0,53 to 0,86 and to 1″,18. We may also notice that Capella and Aldebaran,

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Aldebaran, which have a negative sign prefixed to their real motions when the solar motion is 1″,0 are affected differently from Arcturus, Sirius, and Procyon, which have a positive sign; and that even the motions of the two last become negative when the solar motion is increased beyond a certain point. It may be easily understood that the motion of Arcturus itself would become negative were we to increase the solar motion till the parallactic motion of this star should exceed its apparent motion.

From these considerations it appears, that a certain equallization, or approach to equality may be obtained between the motions of the stars, or between that of the sun and any one of them selected for the purpose; for instance, the motions of Arcturus and Aldebaran being contrary to each other, may be made perfectly equal by supposing the sun's annual motion to be 1″,85925. For then we shall have the real annual motion of Arcturus towards the parallactic centre 1″,091, and that of Aldebaran towards the opposite part of the heavens, in which the solar apex is placed, will be 1″,091 likewise; the first in a direction 55° 29′ 39″ south-preceding, the latter 88° 16′ 31″ north-following their respective parallels; and a composition of these motions with the parallactic ones arising from the given solar motion, will produce the apparent motions of these stars which have been established by observation. But since Arcturus, by the hypothesis which has been adopted in Table VIII. is a nearer star than Aldebaran, the velocities of the real motions, describing these equal arches will be 1309109 in the former and 1527780 in the latter. And it is not the arches but these velocities that must be equalized. Therefore, in order to have this required equality, let the solar motion be 1″,718865 then will a velocity of 1399478 in Arcturus, and 1399842 in Aldebaran, which are sufficiently equal, occasion such angular real motions in the two stars as will bring them, when compounded with their parallactic motions, to the apparent places in which we find them by observation.

Before we proceed, it will be proper to obviate a remark that may be made against this way of equalization or

or approach to equality. We have said that the calculated velocities are such as would be true if the stars were at the assumed distances, and if their real motions were performed in lines at right angles to the visual ray; to which it may here be objected that the last of these assumptions is so far from having any proof in its favour, that even the highest probability is against it. We may admit the truth of what the objection states, without apprehending that any error could arise on that account, if the solar motion were determined by this method. For if the stars do not move at right angles to the visual ray, their real velocity will exceed the calculated one; so that in the first place we should certainly have the minimum of their velocities: and if we were obliged, for want of data, to leave the other limit of the motion unascertained, it must be allowed to be a considerable point gained if we could shew what is likely to be the least velocity of the solar motion; but a more satisfactory defence of the method is, that if we were to assume a mean of all the angular deviations from the perpendicular to the visual ray that may take place in the directions of the real motions of the stars, the only position we could fix upon as a mean would be an inclination of 45 degrees. For in this case the chance of a greater or smaller deviation would be equal; and when a number of stars are taken, the deviations either way might then be supposed to compensate each other; but what is chiefly to our purpose, not only the angle of 45 degrees, but also any other, that might be fixed upon as a proper one to represent the mean quantity of sideral motions, would lead exactly to the same result of the solar velocity to be investigated. For if the velocities of any two stars were equalized, when their motions are supposed to be perpendicular to the visual ray, they would be as much so when they make any other given angle with it; and it is the equalization or approach to equality and not the quantity of the velocities that is the spirit of this method. I have only to add, that an equalization of the solar motion with that of any star selected for the purpose may be had by a direct method of calculation, and will therefore be of great use in settling the rate of the motion to be determined.

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It must be evident from what has been said, that a certain mean rate, or middle rank, should be assigned to the motion of the sun, unless very sufficient reasons should induce us to depart from this condition. To obtain this end must consequently be our principal aim; and if we can at the same time bring the sidereal motions to a greater equality among each other, it will certainly be a very proper secondary consideration.

There are two ways of taking a mean of the sidereal motions, one of them may be called the rate and the other the rank. For instance, a number equal to the mean rate of the six numbers, 2, 6, 13, 15, 17, 19, would be 12; but one that should hold a middle rank between the three highest and three lowest of the six would be 14. In assigning the rate of the solar motion it appears to be most eligible that it should hold a middle rank among the sidereal velocities. We shall however find that nearly the same result will be obtained from either of the methods.

With respect to our second consideration, we may see that it also admits of a certain modification by the choice of the solar motion; for in Table IX. when this motion is 1",5 the velocity of Arcturus 1565735, will exceed that of Sirius, 217007, more than seven times; whereas a solar motion of 1" will give us the proportional velocities of these stars as 188867 to 465174; and the former will then exceed the latter only four times.

Calculations for drawing Figures that will represent the observed Motions of the Stars.

The necessary calculations for investigating the solar motion are of considerable extent, and may be divided into two classes, the first of which will remain unaltered whatsoever be the solar motion under examination, while the other must be adjusted to every change that may be required.

The direction of the sun remaining as it has been settled in the first part of this Paper, the permanent computation of each star will contain the annual quantity of the observed or apparent motion, its direction with the parallel of the star, its direction with the parallactic motion, and

and its velocity. The changeable part will consist of the angular quantity of the real motion, the parallactic direction of this motion, and its velocity.

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Before we can make a calculation of the required velocities, we must fix upon the probable relative distance of the rest of the stars, in the same manner as we have done with the first six. In this I have thought it advisable to distinguish the stars that, from their lustre, may be called principal, and have limited their extent to the brightest of the second magnitude, on account of the uncertainty which still remains about their progressive distances. For though it appears reasonable to allow that the bright stars of the second magnitude may be twice as far from us as those of the first, it will admit of some doubt whether this rule ought to be strictly followed up to the 3d, 4th, 5th, and 6th magnitude; especially when it is not easy to ascertain the boundaries which should limit the magnitudes of very small stars.

The number of these principal stars is 24. The remaining 12 are also arranged by admitting that their magnitudes express their relative distances; and notwithstanding the doubtfulness we have noticed, their testimony with respect to the proper quantity of a solar motion, though it should be received with some diffidence, must not be neglected; some considerable alteration in their supposed distances, however, would have but little effect upon the conclusions intended to be drawn from their velocities.

The following Table contains the result of the calculations that relate to the permanent quantities. In the first and second columns, we have the names of the stars, and their assigned relative distances. The third gives the apparent angular motions, and the fourth their direction. The fifth contains the direction of the same motions, with respect to the parallactic motions arising from the given solar direction; and the sixth gives the velocity of the stars which produce the quantity of the apparent motions.

 Table

Table X.

Names of the Stars.	Proportional Distances.	Apparent Motions.	Direction with the Parallel.	Direction with the parallactic Motion.	Velocity of the Stars.
Sirius	1,00	1″,11528	68.49.40,7 *sp*	10.24.44,3 *sf*	1115281
Arcturus : ..	1,20	2,08718	55.29.42,0 *sp*	0. 0. 3 *sp*	2504621
Capella.	1,25	0 46374	71.35.22,4 *sf*	24.40.21 *sf*	579668
Lyra.	1,30	0,32435	56.20.57,3 *nf*	92.49.30 *nf*	421657
Rigel	1,35	0,16273	79.29.33,9 *np*	159.28. 1 *np*	219684
αOrionis....	1,35	0,13038	85.38.14,6 *nf*	169.18.58 *np*	176010
Procyon....	1,40	1,23941	50. 2.24,5 *sp*	9.40.46 *sp*	1735172
Aldebaran ..	1,40	0,12341	76.29.37,3 *sf*	13.41.48 *sf*	172778
Pollux	1,42	0,65037	0. 0. 0 *prec.*	61.30.34 *sp*	923523
Spica.	1,44	0,19102	84. 5. 1,8 *np*	144.13.16 *np*	275065
Antares	1,46	0,26000	90. 0. 0 *north*	178.57.44 *np*	379600
Altair	1,47	0,71912	48.40.12,0 *nf*	103.17.29 *nf*	1057105
Regulus	1,48	0,22886	20.27.37,5 *np*	70. 9.20 *sp*	338711
βLeonis	1,50	0,55324	7.16. 8,4 *sp*	40.34.31 *sp*	829856
βTauri.	1,50	0,10039	84.58.27,1 *sf*	13.17.11 *sf*	150579
Fomalhaut..	1,50	0,30698	11.16.16,3 *nf*	16.47. 5 *sf*	460469
αCygni.	1,60	0,06440	27.45.56,3 *np*	177.31.39 *np*	103036
Castor	2,00	0,13294	17.30.40,6 *sp*	45.25.43 *sp*	265869
αOphiuchi ..	2,00	0,07698	40.30.24,8 *sf*	33.29.28 *sf*	153955
αCoronæ ...	2,00	0,23279	7.24.15,4 *sf*	105. 0.43 *nf*	465587
αAquarii ...	2,00	0,20615	67.10.17,1 *np*	162.43.46 *nf*	412295
αAndromedæ	2,00	0,09268	40.20.48,2 *sf*	12.55.11 *sf*	185360
αSerpentis ..	2,00	0,21913	60. 7.12,5 *nf*	161.34. 4 *nf*	438257
αPegasi	2,00	0,18917	72. 5.16,0 *np*	157.45.25 *nf*	378338
αHydræ	2,30	0,16598	57.30.24,8 *np*	107. 6.24 *np*	381763
α^2 Libræ	2,40	0,18376	54.42.52,9 *np*	127. 3. 7 *np*	441022
γPegasi.....	2,50	0,17355	59.48. 7,9 *np*	174. 5.15 *nf*	433880
αArietis	2,50	0,11587	37. 9.15,9 *sf*	29.32.47 *sf*	289685
αCeti	2,80	0,14406	33.44. 2,9 *np*	141.18.55 *np*	403356
αHerculis. ..	3,00	0,23000	90. 0. 0 *north*	168.23.41 *nf*	690000
βVirginis ..	3,00	0,77706	17.59.25,5 *sf*	111.11.44 *nf*	2331169
γAquilæ....	3,00	0,19320	55.54.41,7 *np*	178.25.20 *nf*	579589
α^2 Capricorni	3,50	0,26452	79.23.35,3 *nf*	136.21.18 *nf*	925819
βAquilæ....	4,00	0,35127	85. 7.37,0 *sp*	39.49.15 *sp*	1405079
α′ Capricorni	4,20	0,28000	90. 0. 0 *north*	146.59.44 *nf*	1176000
α′ Libræ	6,00	0,20898	59.27.58,4 *np*	131.46. 7 *np*	1253875

The contents of this Table will enable us to examine the motions of the stars in different points of view. For instance, by the apparent motions in the third column, and their directions in the fourth, a figure may be drawn which will represent the actual state of the heavens, with respect to those annual changes in the situations of our 36 stars, which in astronomical tables are called their proper motions.

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Fig. 1, Plate VI. gives us these motions brought into one view, so that by supposing successively every one of the stars to be represented by the central point of the figure, we may see the angular quantity and direction of the several annual proper motions represented by the line which is drawn from the centre to each star. By this means we have the comparative arrangement and quantity of these movements with respect to their directions.

Fig. 3 represents the same motions, but instead of being drawn so as to show their directions with regard to the several meridians and parallels of the stars, they are laid down by the angles contained in the fifth column; and will therefore indicate their arrangement with respect to a line drawn from the solar apex toward the parallactic centre. These directions will remain the same, whatever may be the velocity of the solar motion upon which we shall ultimately fix, provided no change be made in the situation of the apex toward which the sun has been admitted to move.

In these two figures, the lines drawn from the centre give us only the angular changes of the places that have been either observed or calculated, and not the velocities which are required in the stars to produce them. It will therefore be necessary to represent the velocities by two other figures, in which the same directions are preserved, but where the extent of each line is made proportional to the distance of the stars in the second column.

Fig. 2 is drawn according to this plan; the angles of the directions remain as in the fourth column, but the lines are lengthened so as to give us the velocities contained in the sixth.

In Fig. 4, the angles of the 3d figure are preserved, but the lines are again lengthened as in Fig. 2.

N. B. These

N. B. These two last figures would have been of an inconvenient size if they had been drawn on the same scale with the two foregoing ones, for which reason, in comparing the 2d and 4th with the 1st and 3d, it must be remembered that the former are reduced to one half of the dimensions of the latter.

[The Conclusion in our next.]

XII.

Discovery of a New Vegetable Principle in Asparagus. (Asparagus Sativus. Linn.). By Messrs. VAUQUELIN *and* ROBIQUET*.

New vegetable principle in asparagus.

BY examining more attentively than was formerly done the products of vegetation, modern chemists have distinguished a great number of substances unknown to the antients; but it is a long time, I apprehend, since any immediate principle has been discovered which is so singular and interesting as that of which we are about to speak.

During the last summer, Mr. Robiquet, a young chemist, who unites solidity of reasoning to a great skill in experiments, subjected upon the invitation of Mr. Parmentier, the juice of asparagus to chemical analysis, of which the interesting results are to be found in our Annals.

Two kinds of crystals formed in the juice of asparagus.

Having set aside in my laboratory, during a journey which he made, a certain quantity of the juice of asparagus, concentrated by evaporation, I observed a considerable number of crystals, among which two appeared to me to belong to new substances; and as their form, transparency and taste were different, it was easy for me to separate them.

Description of one kind

One of these kinds was perfectly white and transparent after having been several times crystallized.—Its taste is cool and slightly nauseous, so as to occasion a

* Annales de Chimie, Jan. 1806.

secretion

secretion of the saliva; it is hard, brittle, and of a regular form.

The other kind which is also white, is not so transparent nor hard, neither has it the same form; on the contrary, it has little consistence, is crystallized in the shape of fine needles, and its taste is perceptibly saccharine, resembling that of manna. and of the other.

Mr. Robiquet in making the analysis we have alluded to, had noticed the first of these substances, but he took it for an ammoniacal salt, because in the very small quantity of imperfectly purified crystals he could then obtain, it retained between its plates. According to all appearance, some traces of salt with base of ammonia, with which the juice of asparagus abounds, and which misled him. Since that time we have in conjunction submitted this substance to new experiments, the principal of which follow. The form which it effects in its crystallization, according to M. Hauy, to whom we sent a certain quantity, is derived from a right rhomboidal prism, of which the great angle of the base is about 130 degrees. The borders of this base, and the two angles, situated at the extremity of its greater diagonal, are replaced by facets. Figure of the first kind of crystals.

This substance is moderately soluble in water, and its solution gives no signs of acid or alcali. The infusion of nut galls, the acetate of lead, the oxalate of ammonia, the muriate of barytes, and the hydro-sulphuret of potash, produced no change in its solution. Alcohol does not dissolve it. They are soluble in water, and neither acid nor alkaline.

As these experiments indicate that the substance in question is not a salt with an earthy base, we triturated a certain quantity with caustic potash and a little water, in order to see whether ammonia would be disengaged; but no traces were exhibited. The potash appeared to us to render it more soluble in water. They are not earthy nor ammoniacal.

As we saw that it contained neither earth nor ammonia, we directed our enquiries to ascertain the existence of the alcalis, and for that purpose we burned a somewhat considerable quantity in a crucible of platina. At first it swelled up and emitted penetrating vapours which affected the eyes and the nose like the smoke of wood. It afforded a large portion of charcoal, which had no taste and left —nor neutral.

left nothing after its incineration but an almost imperceptible trace of earth, which no doubt was casually present.

Towards the end of the decomposition of this substance, the odour which was disengaged was somewhat similar to that of animal matter, and likewise inclining to that of ammonia.

Action of nitric acid.

The nitric acid decomposes this substance, nitrous gas being disengaged while the fluid assumes a yellow colour and a bitter taste, like animal substances. When the action of the nitric acid is completed, lime disengages abundance of ammonia from the liquid.

This alkali is therefore formed in the operation we have described, since the substance from asparagus did not afford perceptible signs before.

General conclusions.

This substance is not an acid since it does not redden the tincture of tarnsole, and has not the taste which all these substances have in a more or less eminent degree.

It is not a neutral salt because it contains neither earth nor alkali; but as it affords by means of fire the same products as vegetables, we are obliged to consider it as an immediate principle of asparagus.

It is probable that like them it is composed of hidrogen oxigen, and carbon, in particular proportions; it is no less probable that it has likewise a small quantity of azote; this at least seems to be indicated by the smell, which is disengaged by heat, and the ammonia which it forms with the nitric acid.

The authors intend to pursue their experiments.

Though we have obtained a considerable quantity of this substance, we have not been able to submit it to a greater number of experiments, because most part of it was scattered in our laboratory, and there only remained the little portion which we gave to Mr. Hauy to determine its form. We have nevertheless thought it proper to communicate these facts to the Institute, in order to fix the date of its discovery, and it is our intention to proceed in our examination on the return of the asparagus season. We shall also endeavour to ascertain whether this singular matter do not exist in other vegetables.

The second kind of crystals was probably manna.

With regard to the saccharine matter which we also found in the juice of asparagus, we had not a sufficient quantity

quantity to ascertain what species of sugar it might most nearly resemble; we take it to be manna.

We may therefore consider it as decided that besides the principles discovered in the juice of asparagus by Mr. Robiquet, there exists in it a principle which is crystallizable like the salts, but is neither acid nor neutral, and of which the solution in water is not affected by any of the reagents usually employed to ascertain the presence and nature of the salts dissolved in water; and also another principle which appears to resemble manna. Conclusion.

XIII.

A Chemical Examination of Native Cinnabar. By M. Klaproth.

I. *The Cinnabar of Japan.*

External characters of the cinnabar of Japan.

THE cinnabar of Japan is brought to Europe in the form of single grains, more or less large and crystalline. Its colour is of a deep cochineal red, approaching the grey colour of steel in the places which are not damaged; in others it is of a scarlet red, inclining to a brick-dust colour. The grains are fragments of flattened hexahedral prisms; externally smooth and of a metallic lustre; internally very bright and of a semi-metallic lustre. Their fracture crosswise is conchoidal, but longitudinally, it is obscurely lamellated. This mineral is tender, its scrapings of a scarlet red, and its specific gravity=7.710. Its fragments sometimes include specks of pyrites, and in other instances they adhere to a quartzose gangue. In order to distribute these heterogeneous parts uniformly through the mass of grains subjected to analysis, they were mixed and pounded together.

Impurities separated from the cinnabar by heat.

A. One thousand grains of this powder were sublimed in a small glass retort with a receiver adapted thereto, and filled with water. The water of the receiver acquired a turbid yellowish appearance from the particles of sulphur, which were volatilized. It had a faint smell of sulphurated hidrogen, and a slight taste of sulphureous acid. The matter remaining in the retort weighed 38 grains. It was digested

digested with muriatic acid; the iron from the pyritous particles was dissolved and the quartzose gangue remained.

Solution of the metallic part.

B. One hundred and four grains of the mineral, which from the preceding experiment contained 100 grains of pure cinnabar, were reduced to an extremely fine powder, and put into 500 grains of muriatic acid (sp. grav. 1,125) and heated: sulphurated hidrogen gas was disengaged. Into the solution was poured drop by drop, 100 grains of nitric acid (sp. grav. 1,235). Every time the acid was added, there was an immediate effervescence. In this manner the process was carried on till the decomposition of the cinnabar, and the complete solution of the metallic parts were effected.

Combustion of the sulphur.

b. The sulphur that remained was of a greyish yellow colour and in some degree viscid: it weighed 11,8 grains. It was burned in a roasting test and left a blackish residue of 1,5 grains, so that the contents of pure sulphur were 10,3.

c. The lively action of the nitric acid upon cinnabar, gives reason to believe that part of the sulphur was converted into sulphuric acid, by the oxigen of the decomposed nitric acid.

Deduction of the quantity of sulphur which had been acidified, and thence the proportion of mercury and sulphur in the cinnabar.

In order to ascertain the quantity of sulphur which had undergone this change, the solution of the metallic part of the cinnabar (which was of a yellow colour, on account of iron) was taken and decomposed by means of a solution of muriate of barytes. The sulphate of barytes which fell down, after having been ignited, weighed 30 grains; which answers to 4,2 grains of sulphur. A small quantity likewise escaped which has contributed to the formation of sulphurated hidrogen gas; but as this quantity did not exceed one fourth of a grain, we may conclude that 100 parts of pure cinnabar contain 14,75 of sulphur.

Analysis in the dry way afforded the same result.

C. 1040 grains of the mineral, containing, according to the essay A, 1000 grains of pure cinnabar, were mixed with half their weight of iron filings, and distilled in a suitable apparatus: the mercury thus obtained, being carefully collected weighed 845 grains.

From

From these essays we may conclude that 100 parts of Japan cinnabar, exclusive of its foreign parts, contain

Mercury . . .	84,50
Sulphur . . .	14,75
	99,25

II. *Cinnabar of Neumaerktel in Carniola.*

External characters of the cinnabar of Carniola.

Among the cinnabar mines of Europe, that of *Terhitz* on the mountain of *Loibl* near Neumaerktel, in Carniola, is particularly distinguished by the beauty of the specimen it affords.

The colour of this mineral is of a lively cochineal red. It is found in masses of considerable size, in a compact calcareous stone, of a blackish grey, and crossed by veins of white calcareous spar. The faces of contact of the ore against its gangue are brilliant, with a metallic aspect; the cross fracture is of little brilliancy, of a shining greasy aspect. It is obscurely luminated and irregular in other directions. The fragments are of an indeterminate form with obtuse edges. The masses are composed of thin separate laminæ, striated on the faces of separation. This mineral is translucid; its scrapings or powder of a very lively scarlet; it is very tender, and weighs 8,16.

Analysis as before in the dry way.

A. 100 grains of this cinnabar were reduced to very fine powder, and then boiled in 500 grains of muriatic acid. Sulphurated hidrogen gas was separated, and 100 grains of nitric acid was gradually added. The metallic part having been entirely dissolved, there remained 10,20 grains of sulphur of a clear yellow, which being burned on a test, left no residue. The muriate of barytes precipitated 27 grains of sulphate of barytes, containing 3,80 grains of sulphur. Admitting three fourths of a grain of this substance to have existed in the sulphurated hidrogen gas, it will follow that 1425 parts of sulphur were contained in 100 of the cinnabar.

The same by heat.

B. Five hundred grains of cinnabar were distilled with half its weight of iron filings. The mercury obtained from this operation, carefully collected, weighed 425 grains,

grains, whence it follows that 100 parts of cinnabar, contain by analysis

Mercury . .	85,0
Sulphur . .	14,25
	99,25

XIV.

Notice of some Experiments made by the Galvanic Society at Paris.*

Pile without any moisture.

1. M. MARECHAUX, of Wesel, correspondent of the Galvanic Society, announced to them that he had determined that water, whether pure or mixed with an acid, or charged with any salt, is not indispensably required for producing the effects of galvanism. He added, that some time ago he had constructed columns of zinc and brass with the interposition of discs of card, *not moistened*, which were very useful. The Galvanic Society was of course desirous of verifying a fact of this nature, and determined to repeat the experiments of M. Marechaux, as described in his letter.

—verified by experiment.

Discs of zinc, which had been before used, were cleaned and restored to their usual polish. Similar pieces were made out of new *brass*. A vertical column of 49 pieces of discs was formed by the interposition of pieces of card, *not moistened*, standing upon a plate of brass, of greater dimensions, having three holes near its edges, through which, cords of silk were passed in order to support the whole apparatus. These cords were tied together at top, and the whole column suspended by them. This pile which M. Marechaux distinguishes by the name of *Colonne pendule*, was put into communication with the electric micrometer of M. Marechaux, simplified by M. Veau de Launay † and it manifested an intensity of 360 degrees ‡, which

It was weak.

* Annales de Chimie, Jan. 1806.

† See Journ. de Phys. Messidor, an. XIV.—See also our Journal, XIV. p. 350.—N.

‡ By intensity we denote the measure of the distance, at which a leaf

which was ascertained to be the effect of galvanic action, and not from the electricity of the atmosphere.

This first experiment was repeated and varied in different ways. Blotting paper was substituted instead of the pieces of card to the number of four for each, and there was no effect produced. Discs of card, dried in the oven were used, and the mean term of attraction in several experiments was 372 degrees. With the same pieces and twenty-five pair of discs only, the attraction was 160. The experiment was afterwards made with a column, having the same number of pairs of metallic discs but without the interposition of any pieces of card. In these circumstances no effect was produced. The same repeated.

These first results would have been sufficient for the Society to confirm the fact announced by M. Marechaux, and which was intended to be verified; but this galvanic action of the pendulous column was not proved, but by the help of an instrument of very great sensibility, and with regard to quantities scarcely to be estimated. It remains therefore for the Society to ascertain the advantage which it is possible to derive for the progress of galvanism, by means of a discovery so important, by employing more powerful modes of action, and by comparing them with the effects obtained from piles excited by humidity or by saline solutions. The class of the Society which is employed on physical researches, has been charged to direct its investigations. Question how far they may prove useful.

II. A notice appeared in the Moniteur of the 22nd of Brumaire last, that Dr. Joseph Baronio of Milan, had published a description of a galvanic pile, formed of vegetable matters only, with an invitation to philosophers to repeat and vary his experiments, flattering himself that they would serve to extend the application of the theory of galvanism to the whole of vegetable life. The Galvanic Society was called upon to answer this observation of Dr. Baronio*. Pile of vegetable matter only.

a leaf of gold, suspended to a vertical stem of brass, is attracted towards another stem of the same metal, terminating in a ball, when these two stems are in communication with the two poles of the pile. Each degree of this measure answers to the eighteen thousandth of an inch.

* Annales de Chimie, Jan. 1806.

A pile

The experiment repeated.

A pile was accordingly formed by them in his manner: sixty equal discs of walnut-tree were made, two inches in diameter, having a raised edge of one eighth of an inch high. These pieces were boiled in vinegar and with these and round pieces of raw beet root and of a thick raddish, (raphanus sativus of Linnæus,) a pile was constructed of sixty couple of pieces of beet root and raddish, separated by discs of wood, on the upper extremity of each of which was poured by means of the border, a solution of the acidulous tartrite of potash in vinegar. Lastly, at the lower extremity of the pile was placed a leaf of cochlearia, and at the upper extremity a double-band of blotting paper, steeped in vinegar. Every thing being thus disposed agreeably to the full description inserted in the Moniteur; frogs properly prepared for the action of this pile, were placed with the leaf of cochlearia in contact with their spinal marrow, and the band of paper with their muscles. Three frogs being thus successively and repeatedly presented, shewed not the least motion, though they were sufficiently sensible to be strongly agitated when being supported on a knife to bring them near the conductor of the pile, they were in contact with the blade or silver mounting of the handle. After having made every probable experiment with these frogs without success, the pile was brought into communication with the electomicrometer, upon which also it produced no effect. The same instrument was then presented to a pendulous pile, constructed after the manner of M. Marechaux, composed of 60 pair of new discs of copper and of zinc, with the interposition of pieces of card, not moistened. The intensity was about 180 degrees. At the same moment the frogs which had been presented to the vegetable pile were put into communication with this last, and they gave no indication of sensibility.

It did not succeed.

The electromicrometer more delicate than frogs.

The Galvanic Society did not therefore obtain in the experiments indicated by Dr. Baronio, the results which he announced; but they have served to show that the electro-micrometer made use of, is still more sensible than frogs, to shew the smallest effects of galvanism.

XV.

Observations on the Congelation of Water. *By* M. DISPAN, *Professor of Chemistry at Toulouse.*

ABOUT the close of the winter of the year XI. we had at Toulouse, after several days of a temperature remarkably mild, a return of cold very sudden and strong; the canal was frozen in one or two nights, and there was skating, a spectacle very uncommon in this country. The ice remained for eight hours without thawing; but notwithstanding this, the water under the bridges was never frozen, not even slightly. This singularity was noticed with surprize by every one, and I was for a long time at a loss to discover the cause. I think I now understand it.

Remarkable fact of congelation in standing water, which did not freeze under a bridge.

The earliest and the latter frosts are called white frosts, and their cause is well understood. The white appearance is formed by the dew, which crystallizes as it falls. The hard frosts in the depth of winter are, on the contrary, called black frosts, and this expression is equally applicable to the appearance of the ground in that circumstance. For this effect it is requisite that the cold should have previously deprived the atmosphere of the moisture it contained. Nothing is precipitated; but the water upon the ground or soaked into it becomes solid.

Explanation. Black and white frosts.

In fact, when a cold night suddenly follows a succession of warm days, as happens at Toulouse at the times I mention, an abundant hoar frost succeeds. The still waters receive such a quantity, that their caloric, already in part absorbed at the surface by the coldness of the air, can no longer keep up the fluid state. The hoar frost, or precipitated ice, then forms a pellicle at the surface of the water, and by its contact determines the congelation from one part to the other to a certain thickness.

Their cause.

This is not the case with running waters. These by their continual motion prevent the hoar frost from forming a coating to the surface. The frozen particles as they fall from the atmosphere are immersed and mixed with the stream; and when the coldness of the atmosphere itself

Manner in which running water congeals.

itself determines the crystallization, the same thing happens with regard to the spicular crystals thus beginning to be formed. This is the reason why rivers always begin to freeze near their marshy sides, and at places where the current is the least rapid.

— And standing water, which explains the phenomena.

But to return to the stagnant waters. However abundant may be the deposition of hoar frost, the water beneath a bridge will receive no part of it. The surface of the water has therefore this cause of refrigeration less than at the other parts. Its caloric is not taken away but by the mere contact of the air. This condition would be sufficient to render its congelation much more slow; but its fluidity is not less preserved by its surface being defended from the predominating action of the hoar frost, which would follow if that obstacle were not interposed.

Other facts of the same kind.

These facts enabled me to explain certain experiments urged by a philosophical gentleman at Paris a few years ago, to support his opinion on the existence of a material principle under the name of *frigoric*. The author of these experiments assured me, that in a frosty night the *frigoric* fell perpendicularly from the atmosphere upon the surface of the earth; and he offered the following proof. If plates filled with water be exposed to the open air at night, and it be cold enough, the water will freeze; but if one of these vessels be covered with a pane of glass, or any other body, that water will not freeze, even though the covering body do not rest immediately upon the plate. It is sufficient, continued the author, that the fall of the *frigoric* be interrupted, no matter whether from an higher or lower distance; and to complete his demonstration, he added the following experiment, which at first aspect seems very cogent, and is certainly very interesting. It is as follows: place in the evening, at a certain distance above a plate filled with water, a funnel, of which the diameter shall be less than that of the plate, you will find the next day a ring of ice formed round the circumference; but all the water situated perpendicularly beneath the funnel will remain fluid.

Explanation.

I have not repeated this last experiment; but every thing leads me to conclude that it would succeed in favorable

Dr. Herschel's Investigations respecting the Sun's proper Motion.

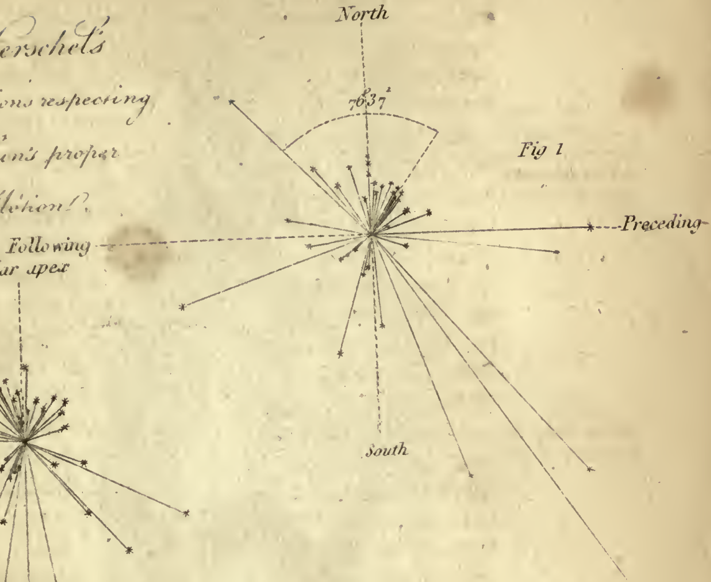


Fig 1

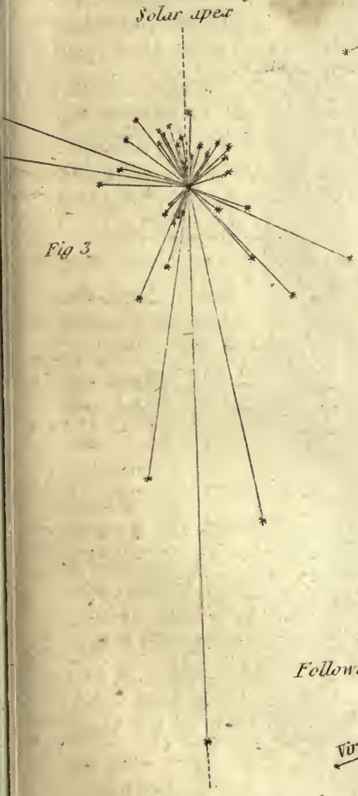


Fig 3

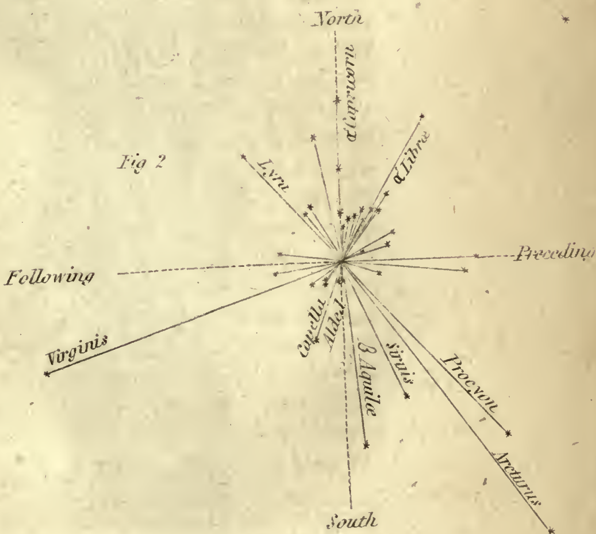
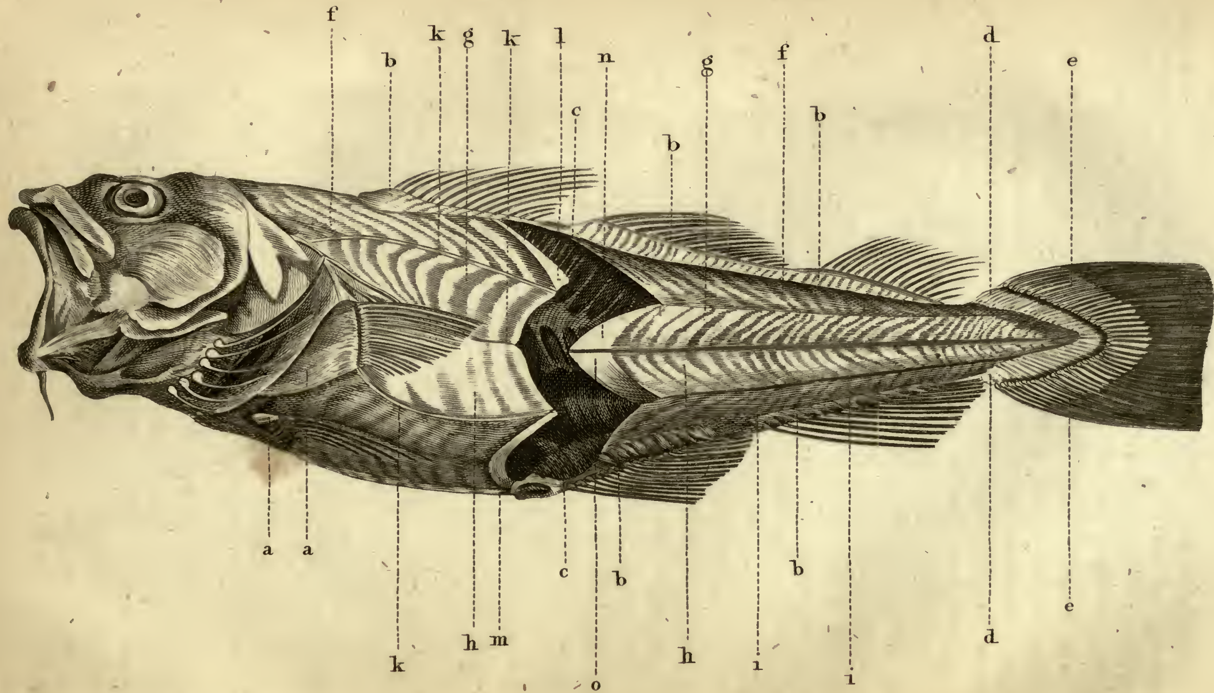


Fig 2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able circumstances; that is to say, when the air holding a certain quantity of water in solution, shall be forced to deposit it all at once in the solid form. We see consequently that in this case, without having recourse to the existence of a frigorific principle, the hoar frost falling on the sides of the funnel will be guided toward the edges of the plate, where a ring of ice will be formed before the middle shall become congealed.

XVI.

Practical Rules for reducing the apparent Distance of the Moon from the Sun or a fixed Star to the true Distance, for the Purpose of ascertaining the Longitude of the Place of Observation. By a Correspondent.

AT some former periods of my life I was not unfrequently in the habit of amusing myself with practical astronomy, and, amongst other departments of it, with what are usually called the common lunar observations. In the course of these it was impossible to avoid remarking that none of the rules given at the end of the "Requisite Tables" for reducing the apparent to the true distances are by any means so short, or so easy to be remembered, as might be wished; and that it would be highly desirable to diminish the labour of this process. I was, indeed, previous to the investigation of the methods hereafter described, usually accustomed to prefer the direct solution of the two triangles, in the former of which the apparent co-altitudes and observed distance are given, and the vertical angle required, and in the other of which the true co-altitudes and azimuthal angle are given, and the base or true distance required. The following methods of performing this reduction, which I then hit upon, appearing however to me to be somewhat more eligible than any others which I have seen, I shall venture to communicate them to the public through the medium of the Philosophical Journal. They are all founded on the two following well-known analogies, viz. That the rectangle of the sines of the sides containing the vertical angle

Origin of the Investigation.

Former rules prolix and burthensome to the memory.

Analogies on which the following rules are founded.

angle : the square of radius : : the rectangle of the sines of the differences between the half-sum of the three sides, and each of those first-mentioned sides : the square of the sine of half the contained angle; and : : the difference between the versed sines, (or the sum or difference of the co-sines,) of the base and of the difference of the sides : the versed sine, (or sum or difference of radius and co-sine,) of the same angle.

RULE I*.

First rule.

1. If the apparent distance be greater than 90°, take the sum, otherwise take the difference, of its natural co-sine and the natural co-sine of the difference of the apparent altitudes, and call it A.

2. Add together the arithmetical complements of the logarithmic co-sines of the observed altitudes, the logarithmic co-sines of the true altitudes, and the logarithm of A; reject 20 from the index, and find the correspondent natural number, which call B.

3. The difference between this number and the natural co-sine of the difference of the true altitudes is the natural co-sine of the observed distance, which will be greater or less than 90° accordingly as B is greater or less than the last-mentioned co-sine.

RULE II.

Second rule, without the use of natural numbers.

1. Add together the two apparent co-altitudes and the apparent distance, and take the difference between their half-sum and each of the apparent co-altitudes separately.

2. Add together the arithmetical complements of the logarithmic co-sines of the two apparent altitudes, the logarithmic sines of the two before-mentioned differences, and the logarithmic co-sines of the true altitudes, and halve the sum.

* Since writing the above I find that there is a method perfectly analogous to this in Mr. Thos. Keith's Trigonometry, published in , and differing only in his using secants in one part of the process instead of co-sines. As I think it, however, a very useful mode of reduction, I have not struck it out, but shall content myself with thus resigning to that gentleman the merit of the first publication of it. Q.

3. Subtract

3. Subtract from this half-sum the logarithmic sine of half the difference of the true altitudes, and the remainder will be a logarithmic tangent.

4. Find the correspondent logarithmic sine, subtract it from the before-mentioned half-sum, and the remainder will be the logarithmic sine of half the true distance.

RULE III.

Third rule, also without the use of natural numbers.

1. Add together the arithmetical complement of the logarithmic sine of half the apparent distance and the logarithmic sine of half the difference of the apparent altitudes, and their sum will be the logarithmic co-sine of an arc, which call A.

2. Add together half the sum of the logarithmic co-sines of the true altitudes, the logarithmic sine of half the difference of the apparent altitudes, and the logarithmic tangent of A.

3. Add together also half the sum of the logarithmic co-sines of the apparent altitudes and the logarithmic sine of half the difference of the true altitudes.

4. The difference between these sums is a logarithmic tangent of an arc, which call B.

5. To the logarithmic sine of half the difference of the true altitudes add the arithmetical complement of the logarithmic co-sine of B, and their sum will be the logarithmic sine of half the true distance.

RULE IV.

Fourth rule, analogous to the last.

1. Add together the arithmetical complement of the logarithmic sine of half the apparent distance and the logarithmic sine of half the difference of the apparent altitudes, and their sum will be the logarithmic co-sine of an arc, which call A.

2. Find the logarithmic sine of A; subtract from it the before-mentioned arithmetical complement, and double the remainder.

3. Add to this doubled remainder the arithmetical complements of the logarithmic co-sines of the apparent altitudes, and the logarithmic co-sines of the true altitudes, and halve the sum.

4. From this half-sum subtract the logarithmic sine of

half the difference of the true altitudes, and the remainder will be a logarithmic tangent.

5. Find the correspondent logarithmic sine; subtract it from the before-mentioned half-sum, and the remainder will be the logarithmic sine of half the true distance.

We will work one of the cases given in the "Requisite Tables" by each of these rules.

EXAMPLE.

Example;— Let the apparent distance of the moon from a star be 89°. 58′. 6″. the apparent altitude of the star 5°. 6′. that of the moon 84°. 46′. and her horizontal parallax 61′. 18″.; what is their true distance?

In this case the correction for the moon's parallax and refraction taken from Tab. VIII. Requisite Tables, is + 5′. 30″.; and that for the star's refraction from Table I.—9′. 44″.; so that their true altitudes are 84°. 51′. 30″. and 4°. 56′. 16″.

Then, by the First Rule.

— worked by the first rule;

Nat. cos. 79°. 40′.	.1793746
Nat. cos. 89°. 58′. 6″	.0005527
A. =	.1788219
Ar. comp. log. cos. 84°. 46′.	1.0399483
5°. 6′.	0.0017228
Log. cos. 84°. 51′. 30″.	8.9523977
4°. 56′. 16″.	9.9983855
Log. A.	$\bar{1}$.2524208
Log. B.	$\bar{1}$.2448751
Nat. cos. 79°. 55′. 14″.	.1750135
B. nat.	.1757418
Diff.	.0007283

= nat. cos. 90°. 2′. 30″. 3. the true distance.

Or, by the Second Rule.

— by the second rule;

As. comp. log. cos. 84°. 46'.	1.0399483
5°. 6'.	0.0017228
Log. sin. 5°. 9'. 3''	8.9531696
84°. 49'. 3''	9.9982210
Log. cos. 84°. 51'. 30''	8.9523977
4°. 56'. 16''	9.9983852
	2)38.9438446
	19.4719223
Log. sin. 39°. 57'. 37''	9.8077084
Log. tan. (24°. 46' +)	9.6642139
Correspondent log. sine	9.6222792
Which subtracted from above half-sum, gives	9.8496431

= log. sine 45°. 1'. 15''. 15. half the true distance.

Or, by the Third Rule.

— by the third rule;

As. comp. log. sin. 44°. 59'. 3''. ..	0.1506351
Log. sine 39°. 50'.	9.8065575
Log. cos. A. (= 25°. 1'. +)	9.9571926
Log. cos. 84°. 51'. 30''	8.9523977
4°. 56'. 16''	9.9983852
	2)18.9507829
	9.4753914
Log. sin. 39°. 50'.	9.8065575
Log. tan. A.	9.6691375
1st Sum.	28.9510864

Log. cos. 84°. 46'.	8.9600517
5°. 6'.	9.9982772
	2)18.9583289
	9.4791644
Log. sin. 39°. 57'. 37"............	9.8077084
2d Sum	19.2868728
Diff. sums = log. tan. B. (=24°.46'. +)	9.6642136
As. comp. correspond. log. cos. ..	0.0419345
Log. sin. 39°. 57'. 37"............	9.8077084
Sum=log. sin. 45°. 1'.15".15 as before	9.8496429

Or, by the Fourth Rule.

—by the fourth rule.

As. comp. log. sin. 44°. 59'. 3"....	0.1506351
Log. sin. 39°. 50'.	9.8065575
Log. cos. A. (= 25°. 1'. +)....	9.9571926
Log. sin. A.	9.6263301
Diff. bet. it and the above as comp.	9.4756950
	2
	18.9513900
Ar. comp. log. cos. 84°. 46'.	1.0399483
5°. 6'.	0.0017228
Log. cos. 84°. 51'. 30".	8.9523977
4°. 56'. 16".	9.9983852
	2)38.9438440
Half-sum....	19.4719220
Log. sin. 39°. 57'. 37"............	9.8077084

Log. tan. (24°. 46'. +)	9.6642136
Correspondent log. sine, which subtract from above half-sum	9.6222790
Diff.=log. sin. 45°. 1'. 15". 15. half the true distance, as before	9.8496430

The advantages of the preceding modes of reduction are, that they are not difficult in practice, that they are perfectly correct, that they may be applied without using any but the common tables, that they are not incumbered with any complex distinction of cases, and that their results are void of ambiguity.

Advantages of these rules.

16*th Dec.* 1805. Q.

SCIENTIFIC NEWS.

National Institute of France.

THE Class of Mathematical and Physical Sciences of the National Institute of France held its public session on the 7th of July last. The order of the readings was as follows:

National Institute of France, July 7, 1806.

1. The mathematical prize proposed for the month of January 1809 was announced.

2. A notice of the proceedings of the Class, from the 1st Messidor in the year XIII. to the 1st July 1806, philosophical department, was read by M. Cuvier, the perpetual secretary.

2. A like notice of the mathematical part of the Class during the same interval was read by M. Delambre, perpetual secretary.

4. A memoir on the affinities of bodies for light, by M. Biot.

5. A memoir on the adhesion of the particles of water to each other. By the Count of Rumford, foreign associate.

6, Historical Eulogium on M. Cells. By C. Cuvier.

The

The subject of the mathematical prize, and the prospective remarks upon the same, were as follow:

Prize question.

It is required to establish a theory of the perturbations of the planet Pallas, discovered by Mr. Olbers.

On the computations for determining the respective places of the last discovered planets.

Geometers have given the theory of perturbations sufficiently extensive and accurate for all the planets formerly known, and for all those which might be discovered, provided they were confined to the same zodiac and had little eccentricity.

Mercury until our time was the most eccentric of all the planets, and at the same time that which had the greatest inclination; but its small mass, and its situation at one of the limits of the planetary system, render it of little effect to produce any sensible alterations in the motions of the other planets; Uranus, discovered twenty-five years ago by Dr. Herschell, is placed at the other limit of the system. With a small mass and moderate eccentricity it has also the smallest of all the known inclinations; so that the formulas which had served for Jupiter and Saturn have been more than sufficient for this modern planet.

Ceres, discovered five years ago by Mr. Piazzi, having with a considerable eccentricity an inclination 10° 38′, must be subject to great and numerous inequalities. It appears, nevertheless, that all the astronomers who have laboured to determine them have been content with the known formulas, of which the developement does not exceed the products of three dimensions of the eccentricities and inclinations. Those of five dimensions have been used in the Mécanique Céleste according to a formula of Mr. Burckhardt. The same astronomer has since presented the general and complete developement of the third, fourth, and fifth orders; but this degree of precision is not sufficient for Pallas, of which the eccentricity is greater than even that of Mercury, and the inclination 34° 38′ is five times as much as that of any antient planet. It is even difficult to conjecture what may be the powers and what may be the dimensions of the products which admit of being neglected; so that the calculations may be so long, and the formulas so complicated

cated as to discourage geometers and astronomers the best qualified to execute a work of this kind.

Two years ago the Class of Physical and Mathematical Sciences of the Institute determined, from this consideration, to propose the subject for the prize to be distributed at the public sitting on the first Monday in Messidor of the year XIV. But the term having appeared too short, and the number of the planets being again increased by the discovery of Juno by M. Harding, of which the eccentricity appears to be still greater than that of Pallas, and the inclination of 13 degrees greatly exceeds that of all the other planets except Pallas; the Class has thought proper to propose the same subject again, with some modifications and a double prize. They accordingly invite astronomers and geometers to discuss completely all the points of this theory, with the omission of none of the inequalities which may become sensible; and as these inequalities cannot be well determined if the elliptical elements be not perfectly known, it is indispensible that the concurrents should not confine themselves to give the numerical coefficients of the equations. It is more particularly important to exhibit analytical formulas, in order that substitution may be successively made of more exact values of the mean distance, the eccentricity, the perihelium, and the inclination, accordingly as the elements shall become better known. The concurrents may even dispense with giving any numerical value, provided the analytical expressions be presented sufficiently in detail to enable an intelligent calculator to follow the developement and reduce them into tables.

Another advantage will result from these general formulas; namely, that the planets Ceres, Pallas, and Juno being at distances from the sun so little different that it can scarcely at present be with certainty decided which of the three is the nearest or the most remote: the formula given for Pallas may serve equally for the two others, as well as for every planet which may hereafter be discovered which shall have its eccentricity and inclination within the same limits.

The Class entertains the hope that this question will appear of sufficient interest to geometers to induce them

 to

to make exertions proportioned to the difficulty of the subject. The prize which will be proclaimed in the public sitting of the first Monday in January 1809 will be a gold medal of 6000 francs (£250).

The works presented must be written either in French or in Latin, and will not be received later than October 1, 1808. This term will be strictly attended to. The other conditions are as usual.

Nitrate of Soda.

Nitrate of soda burns three times as long as common nitre, &c.

Professor Proust writes to Dr. Delamethere, that he finds the nitrate of soda an economical article for fire works. Five parts of the nitrate, one of charcoal and one of sulphur, afford a powder which gives a flame of a reddish yellow, of considerable beauty: and the mixture burned in a metallic tube, will last exactly three times as long as the same charge of common powder.

The nitric acid in this combination is not decomposed to the same degree as that of nitrate of potash. Its gases are a mixture of carbonic acid, with a small quantity of gaseous oxide of azote, and much nitrous gas.

The cheapest method of obtaining nitrate of soda, would no doubt be to use soda, instead of potash, to saturate the mother waters.

Examination of the Birds' Nests which are eaten in China, and other Eastern parts.

Birds' nests of the East.

The same chemist has examined the birds' nests of the East and finds them to consist merely of a single piece of cartilage, uniform in its texture. He boiled one in water, which became soft, but was not separated in its parts and what was still more remarkable, it lost only four hundredths of its weight.

Subterraneous Road or Tunnel, made upwards of three Centuries ago (Journal des Mines, Fev. 1806).

Subterraneous passage or tunnel in Italy, made in the fifteenth century.

The Marquis (de Saluces) Louis II. being desirous of increasing the commerce of the country dependant on his sovereignty, undertook in the fifteenth century to make an excellent road in the valley of the Po, which passing

passing over a mountain, placed beside Mount Viso, called La Traversetta, should lead into Dauphiny.

But as this passage was surrounded by frightful precipices and was only passable for men on foot, he dug through the body of the mountain, a passage, which, without the assistance of gunpowder, was completed in less than five years. This passage is 74 metres (about 80 yards) in length, four in width, and about the same in height.

The opening through this mountain has been attributed by some to the ancient Romans, at the time when they penetrated into Gaul; others have ascribed it to the celebrated warrior of Carthage, who made the Romans tremble, and was their eternal enemy. But it is certain that it was effected by the Marquis Louis II. The acts relating to several undertakings, composing part of this work, still exist in the archives of the former office of Secretariat of the interior of Piedmont, and Mr. Bresli, sub-prefect of the Arrondissement, author of Notices Historiques de la Ville de Saluces, published at Turenne in the year XIII. asserts that he himself being occupied on the spot in clearing this passage from rocks and other obstacles which had detached themselves from the mountain, observed on the right hand within the same passage, the engraved date of 1480, the epocha at which this work was finished.

Method of conveying Carp and Pike to great Distances alive.

This method which is no less simple than easy, and which I am informed is also practised in England, is mentioned in La Revue. It may be practised by any proprietor of ponds, and may afford a good return if used in situations where carriage may easily be had. The fish it is said, may be thus conveyed some hundreds of miles, in a state of life and health equal to what they possessed when first caught. Carp and Pike.

Crumb of bread is soaked in brandy, and when well swelled, it is used to fill the whole of the fish's mouth, into which, half a glass more of the spirit is then to be poured. The fish remains motionless and as if deprived of life;

life; in which state it is to be wrapped in fresh straw, and afterwards in a cloth.

In this condition the fish may be kept or conveyed to any distance for eight or ten days. When arrived at the place of destination, they must be unpacked and thrown into a cistern of water, where they remain a quarter of an hour, or sometimes and hour, without shewing any signs of life; but at the end of that time they disgorge very abundantly and recover their life and ordinary motions.

Horse-Chesnuts as Food for Sheep.

Horse Chesnuts for Sheep.

The fruit of the horse-chesnut tree is collected in Saxony for feeding sheep, where it is considered as an wholesome food and a specific remedy against the rot. It is given to them in Autumn when the green food is no longer to be had. The horse chesnuts are cut in pieces and distributed in the quantity of about two pounds and a half for each, and less for the lambs. Sheep as well as cattle at first refuse it, but greedily take it when custom has made it familiar. They eat the prickly outside with satisfaction. There is danger in giving these fruits without cutting them in pieces, as they may stick in the throat and occasion the death of the animal.

Mr. CUTHBERTSON, No. 54, Poland Street, Philosophical Instrument Maker, and Member of the Philosophical Societies of Holland and Utrecht, has in the Press his Work on Practical Electricity and Galvanism; being a Translation of the most interesting Experiments contained in a Treatise published by him during his residence in Holland, with the addition of all such as have since been invented by Himself and Others; together with an Appendix, containing the most interesting Experiments on Galvanism.

A
JOURNAL
OF
NATURAL PHILOSOPHY, CHEMISTRY,
AND
THE ARTS.

DECEMBER, 1806.

ARTICLE I.

Facts and Observations respecting Vision under Water; and various Particulars relative to Swimming, &c. In a Letter from James Horsburgh, *Esq.*

To Mr. NICHOLSON.

Sir, Walworth, Nov. 6, 1806.

THE perusal of your observations relative to Swimming, in No. 58 of your Journal, and the letters from your correspondent inserted in Nos. 60 and 61, affirming that objects are visible to the human eye under water, which concurs not with your opinion, encourage me to state some few facts relative to this subject, the result of my own observations. On swimming, and vision under water.

In high latitudes the sea is seldom transparent; but within the tropics, and near the equator, the bottom is often visible in from ten to fifteen or twenty fathoms water, when it consists of variegated coral or white sand and coral mixed. In various parts of the Indian seas, Great transparency of the sea between tropics. Bottom seen at 150 feet depth.

the bottom is discernible at the depths mentioned above. In the Mindora Sea I have seen the spotted coral at the bottom when the depth of water over it was twenty-five fathoms; and have often tacked ship on the edges of coral shoals, by the appearance of the bottom, in depths of ten and twelve fathoms.

The author can see objects with the face under water nearly as well as in the air.

Swimming has ever been my favourite amusement. At Madras, where the surf is high, and ships' boats not permitted to land, I once had the imprudence to swim on shore through the surf, by way of diversion, and returned through it to a boat at a grapnel outside, which nearly cost me my life, being obliged to dive so frequently in resisting many heavy surfs. I have always observed when the bottom was clear, and any object upon it visible when my head was above water, it was nearly as well perceived when my head was under water. At the island Diego Garcia, where the water is very transparent in the harbour and at other places, I have frequently, when swimming under water, seen fishes darting about in various directions, and every article on the bottom very plain. The legs and feet of persons standing at six or eight yards distance were always visible in clear water when my head was under it; and at discretion easily taken hold of, by swimming under water to them with open eyes.

As far as his experience goes, all persons can see under water

I have always supposed that all persons could see under water, if timidity did not prevent them from opening their eyes during immersion; but must own that I have been in company with persons who could swim, but could not be prevailed on to open their eyes under water, affirming that they could not, although they endeavoured to do it. Those persons who could open their eyes with facility whilst immersed, always asserted that they saw objects in the water. Vision under water is probably confined to this element, for I never could distinguish external objects, such as the sun, clouds, &c. but only confused rays of light (in looking upward) were visible.

— but not objects in the air, while themselves are immersed.

Infants probably will float.

It is probable that most infants will float; I have seen one of ten or twelve months old fall from a boat into the water; the mother leaped in and rescued it, apparently without either receiving injury. The natives of China

that

that live in boats do not, however, trust to their children floating naturally, for they keep gourds fixed to their shoulders to prevent them sinking should they happen to fall in the water. This precaution seems prudent in China, the water in the canals and rivers here being of a very soft quality.

Men are apt to drown themselves by raising their hands.

Men who cannot swim, happening to fall in the water, are certainly (as you observe) very apt to drown themselves by pushing their hands and arms above water; for a person cannot sink if the hands are kept under the surface and a gentle motion performed by them. But I cannot avoid observing that Doctor Franklin's remarks relative to the specific gravity of the human body in salt and fresh water seem liable to some objections, if indiscriminately applied to all persons, there being great reason to think the specific gravity of the human species differs considerably. The following instance appears to favour this opinion: In company with two friends, some years ago, it was customary for us to proceed to the sea to enjoy the exercise of swimming; this was at Bombay in India; the gentlemen who accompanied me could both swim, but neither of them had ever tried to float on the water without motion. When swimming on their backs they were requested to endeavour to lie quiet without any motion of hands or feet. The best swimmer of the two could not float without using a little motion with his hands or feet, although he repeated the trial several days; when he lay without motion his head gradually sunk till completely under water. This person was of short stature, strong, and athletic. The other gentleman was of a spare make, thin, and delicate in constitution; and at the first trial floated on the surface like a cork, without any motion of hands or feet; his toes, part of his feet, knees, part of his shoulders and head, remained above the surface, when every part of his body was at rest; whilst the stout gentleman could in no position float on the surface without a gentle motion of hands or feet. It certainly appeared to me evident that the specific gravity of these persons differed considerably.

Facts which shew that the specific gravities of men, and consequently their powers of floating, are different.

When the sun has been obscured by clouds, or otherwise not too powerful, I have frequently amused myself by

Particular observations respecting the

situation of floating persons, &c.

by lying on my back without motion for considerable periods of time; sometimes for half an hour, or longer, when the water was mild and smooth; at such times I have found a strong inclination to sleep, which induced me to lie no longer without motion, for fear of carrying this amusement too far. When floating on salt water I have always observed the following effects produced by placing the arms in various positions: 1st. When my arms were placed across my breast, the body floating in the horizontal position, face upwards, in a short time the feet and legs sunk downward, until the body assumed nearly a vertical position; then the head frequently sunk so far as to bring the nose under the surface, but the face quickly resumed its former position above the surface without using the least motion of any limb. The body alters its position, sometimes, by turning round from one side to the other when the feet sink far below the surface, but soon returns to its natural floating position with the back undermost, the legs and feet at the same time ascending to the surface as at first. With the hands laid across the breast this revolution of the body in floating on the sea has been reiterated often in the space of a quarter of an hour without moving a limb.

2nd. When the arms were laid close along each side, over the belly, or under the back, the body was liable to the same revolutions as mentioned above.

3rd. When the arms were stretched in a perpendicular direction from the body, they always prevented it from turning round by acting on the water as levers to retain the body in its natural floating position; although with the arms in this position the feet sometimes descended considerably from the surface, but shortly after ascended to it again.

4th. To keep the body in the horizontal equilibrium, the arms were stretched backward beyond the head, the hands open and resting on the surface of the water; the legs and feet then remained constantly near the surface, the toes generally above it. On drawing the arms from this position gradually forward to the perpendicular direction from the body, the feet always inclined to descend from the surface; but so soon as the arms were

moved

moved more backward, the toes and part of the feet always appeared above water, the body continuing in perfect equilibrium, with the face and toes above the surface, the chest and knees close to it. When the water is not too cold, and the surface smooth, it would be an easy matter to fall asleep floating in this position. Particular observations respecting the situation of floating persons, &c.

None but those who can swim above and under water will readily comprehend the great pressure of the water upward, and how easily it will sopport on its surface human beings, when it is smooth, without any broken water. For amusement I have gone into the sea full dressed into deep water, and by floating in various ways, as most convenient, taken off coat, waistcoat, opened the knee buttons of my smallclothes, taken them and stockings off with equal ease as on shore, and finally pulled my shirt off, swimming then with them to the shore.

Swimming is very easily acquired when a few good lessons are given. Seamen, and others who are liable to be much on the sea, rivers, canals, &c. should not neglect to learn this art.

I am, Sir,

Your most obedient,

and most humble servant,

JAS. HORSBURGH.

II.

On the Quantity and Velocity of the Solar Motion. By WILLIAM HERSCHEL, *L.L.D. F.R.S. From the Philosophical Transactions for* 1806.

[Concluded from p. 242.]

Remarks on the sidereal Motions as they are represented from Observation.

AS we have now before us a set of figures which give a complete view of the result of the calculations contained in the Xth Table, we may examine the arrangements of the stars, and draw a few conclusions from them, that will Investigation of the proper motion of the sun.

Investigation of the proper motion of the sun.

will throw some light upon the subject of our present inquiry.

In the first place, then, we have to observe in Fig. 1, that 17 out of the 21 stars, whose motions are directed towards the north, are crowded together into a compass of little more than $76\frac{1}{2}$ degrees. But this figure, as we have shown, is drawn from observation. We are consequently obliged to conclude, that, if these motions are the real ones, there must be some physical cause which gives a bias to the directions in which the stars are moving; if so, it would not be improbable that the sun, being situated among this group of stars, should partake of a motion towards the same part of the heavens.

Our next remark concerns the velocity of the sidereal motions; and therefore we must have recourse to Fig. 2, where we perceive that the greatest motions are not confined to the brightest stars. For instance, the velocity of β Virginis is but little inferior to that of Arcturus, and exceeds the velocity of Procyon. Likewise the velocities of β Aquilæ, α Libræ, and α Capricorni, surpass that of Sirius; and an inspection of the rest of the figure will be sufficient to show how very far the velocities of Capella, Lyra, Rigel, α Orionis, Aldebaran, and Spica, are exceeded by those of many other stars.

If we look at the arrangement of the stars with respect to the direction of the solar motion, we find in Fig. 3, that a somewhat different scattering of them has taken place; but still most of the stars appear to be affected by some cause which tends to lead them to the same part of the heavens, toward which the sun is moving; and the directions of the greatest number of them are not very distant from the line of the solar motion.

The whole appearance of this figure presents us with the idea of a great compression above the centre, arising from some general cause, and a still greater expansion in the lower part of it. The considerable projection of a few stars on both sides, is however a plain indication that the compressing or dilating cause does not act in their directions.

When the velocity of the stars, represented in the same point of view in Fig. 4, is examined, we find a particularity

ticularity in the direction and comparative velocities in the largest stars that must not be overlooked. Four of them, Rigel, α Orionis, Spica, and Antares, have a motion toward that part of the heavens in which the solar apex is placed, and their motions are very slow. Three other stars of the 1st magnitude, Arcturus, Procyon, and Sirius, move toward the opposite part of the heavens, and their motions, on the contrary, are very quick.

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The direction of the motion of Aldebaran, compared with its small velocity, is no less remarkable; and seems to be contrary to what has been pointed out with the three last mentioned stars; we shall however soon have an opportunity of showing that it is perfectly consistent with the principles of the solar motion.

The Solar Motion and its Direction assigned in the first Part of this Paper are confirmed by the Phenomena attending the observed Motions of the 36 Stars.

An application of some of the foregoing remarks will be our next subject; and I believe it will be found, that in the first place they point out the expediency of a solar motion. That next to this they also direct us to the situation of the apex of this motion: and lastly, that they will assist us in finding out the quantity requisite for giving us the most satisfactory explanation of the phenomena of the observed proper motions of the stars.

In examining the second figure, it has been shown that no less than six stars of the first magnitude, namely, Capella, Lyra, Rigel, α Orionis, Aldebaran, and Spica, have less velocity than nine or ten much smaller stars. Aldebaran and α Orionis indeed have so little motion that there are but three stars in all the 36 that have less. But the situation of these bright stars, from their nearness, must be favourable to our perceiving their real motions if they had any, unless they were counteracted by some general cause that might render them less conspicuous. Now to suppose that the largest stars should really have the smallest motions, is too singular an opinion to be maintained; it follows, therefore, that the apparently small motions of these large stars is owing to some gene-

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ral cause, which renders at least some part of their real motion invisible to us. But when a solar motion is introduced, the parallax arising from that cause will completely account for the singularity of these slow motions.

If the foregoing argument proves the expediency of a solar motion, its direction is no less evidently pointed out by it. For if the parallax occasioned by the motion of the sun is to explain the appearances that have been remarked, it will follow, that a direction in opposition to the motion of Arcturus, will answer that end in the most satisfactory manner. That compression, for instance, which has been remarked in the motions of the stars moving toward the solar apex in Fig. 3, and which is so completely accounted for by a parallactic motion arising from the motion of the sun, points out the direction in which the sun should move, in order to produce this required parallactic motion. The expansion of the motions that are in opposition to the former is evidently owing to the same parallactic motions, which in this direction unite with the real motions of the stars; and as, in the former case, the observed motions are the differences between the parallactic and real motions, so here they are the sum of them.

The remark that stars having a side motion, are not affected by the cause of the compression or expansion, which acts upon the rest, is perfectly explained; for a parallactic motion, in the direction of the motion of Arcturus, can have no effect in lengthening or shortening the perpendicular distance to which a star may move in a side direction.

I have only to add, that the small velocities of Rigel, α Orionis, Spica, and Antares, in Fig. 4, as well as the great velocities of Arcturus, Procyon, and Sirius, point out the same apex which in the first part of this Paper has already been established by more extended computations.

The case of Aldebaran, though seemingly contrary to what has been shown, confirms the same conclusions. This will appear by considering that a star, moving toward the solar apex with a greater real motion than its parallactic one, must continue apparently to move in its real

real direction; but should a star, such as Aldebaran, move toward the apex with less velocity than the parallactic motion which opposes it, there will arise a change of direction, and the star will be seen moving toward the opposite part of the heavens.

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Trial of the Method to obtain the Quantity of the Solar Motion by its Rank among the sidereal Velocities.

According to the conditions that have been explained, a calculation may be made with a view of equalizing the velocities of the sun and the star α Orionis; and the result of it will show that the proposed equality will be obtained when the solar motion is 1″,266230. It will moreover be found that so small an increase of this motion as 0″,01 would give us 19 stars with less, and 17 with more velocity than that which the calculation assigns to the sun; this consequently fixes one of the limits to which the solar motion ought not to come up, if we intend it should hold a middle rank among the sidereal velocities.

On the other hand, by a similar calculation of the velocities of the star Pollux and the sun, it appears that a solar motion of 0″,967754 will make them equal; and that a diminution of this motion not exceeding 0″,01 would give us 19 stars moving at a greater rate than the sun, and only 17 falling short of its velocity. This consequently fixes the other limit to which the solar motion ought not to be depressed. And thus it appears by this method, that the quantity we are desirous of ascertaining, is confined within very narrow bounds, and that by fixing upon a mean of the two limits, we may have the rank of the solar motion true to less than 0″,15.

Calculations for investigating the Consequences arising from any proposed Quantity of Solar Motion, and for delineating them by proper Figures.

Before we can justly examine the real motions of stars which it will be necessary to admit in consequence of a given solar motion, it will be convenient to have them represented in two figures that we may see their arrange-

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ment and extent; and as a calculation of the required particulars will oblige us to fix upon a certain quantity, we shall take the motion that has been ascertained to belong to the middle rank of the sidererl velocities for a pattern. The result of the necessary calculations is as follows:

Table XI.

Names.	Parallactic Motion.	Real Motion.	Parallactic Angle.		Velocity.
Sun........	0",00000	1",116992	00°.00'.00"		1116992
Sirius	0,75697	0,395212	149.20. 6	sf	395212
Arcturus ...	0,59847	1,488713	179.59.55,7	sp	1786455
Capella.	0,88905	0,506123	22.29.12,5	nf	632654
Lyra.	0,36349	0,498949	40.29.14	nf	648634
Rigel	0,55470	0,709381	4.36.52	np	957665
αOrionis....	0,71410	0,842559	1.38.38	np	1137455
Procyon....	0,74161	0,523428	156.32.21	sp	732799
Aldebaran ..	0,72736	0,608148	2.45.15	nf	851407
Pollux	0,78643	0,743971	50.12.11	np	1056439
Spica.	0,74009	0,902004	7. 6.44	np	1298886
Antares	0,74110	1,000835	0.16.10,5	np	1461219
Altair	0,64544	1,071012	40.48. 4	nf	1574431
Regulus	0,75095	0,706833	17.43.53	np	1046113
βLeonis	0,68003	0,443842	54.10.14,5	np	665763
βTauri.	0,73063	0,633317	2. 5.15,5	nf	949976
Fomalhaut..	0,66693	0,383414	13.22. 5,5	nf	575121
αCygni.	0,46516	0,529503	0.18. 2,2	np	847204
Castor	0,55841	0,474647	11.30.32	np	949293
αOphiuchi ..	0,35202	0,290934	8.23.43	nf	581869
αCoronæ ...	0,23427	0,370580	37.21.17	nf	741160
αAquarii ...	0,55743	0,756754	4.38.19,5	nf	1513508
αAndromedæ	0,55389	0,464035	2.33.34	nf	928071
αSerpentis ..	0,38655	0,598458	6.38.54	nf	1196917
αPegasi	0,55567	0,734265	5.35.47,5	nf	1468530
αHydræ	0,46554	0,538281	17. 8.26	np	1238046
α² Libræ	0,43377	0,563892	15. 4.29	np	1353342
γPegasi.	0,44540	0,618272	1.39.27	nf	1545679
αArietis	0,43893	0,342934	9.35.29,5	nf	857336
αCeti	0,33271	0,454165	11.26. 5,5	np	1271662
αHerculis. ..	0,21909	0,446795	5.56.38,5	nf	1340388
β Virginis ..	0,36039	0,967572	48.29. 2,5	nf	2902716
γAquilæ....	0,30898	0,502168	0.36.25	nf	1506503
α² Capricorni	0,31390	0,537285	19.51.52,5	nf	1880497
βAquilæ....	0,24370	0,226458	96.36.59,5	sp	905830
α' Capricorni.	0,26151	0,519230	17. 4.54,5	nf	2180769
α' Libræ	0,17347	0,349371	26.29.44,5	np	2096229

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By the contents of this Table, Fig 5 is drawn with the lines contained in the third column and the angles of the fourth; the scale of it is that of the 5th and 3d figures; and it represents the directions and angular quantities of the real motions that are required to compound with the parallactic effects of the second column, so as to produce those annual proper motions which are established by observation.

Fig. 6 is drawn on the reduced scale of the 2d and 4th figures. The lines make the same angles with the direction of the solar motion as before, but their lengths are in the proportion of the velocities contained in the last column.

Remarks that lead to a necessary Examination of the Cause of the sidereal Motions.

The first particular that will strike us when we cast our eye on Fig. 5, is the uncommon arrangement of the stars. It seems to be a most unaccountable circumstance that their real motions should be as represented in that figure; indeed, if we except only ten of the stars, all the rest appear to be actuated by the same influence, and, like faithful companions of the sun, to join in directing their motions towards a similarly situated part of the heavens.

This singularity is too marked not to deserve an examination; for unless a cause for such peculiar directions can be shown to exist, I do not see how we can reconcile them with a certain equal distribution of situations, quantities, and motions, which our present investigation seems to demand. In order to penetrate as far as we can into this intricate subject, we shall take a general view of the causes of the motions of celestial bodies.

A motion of the stars may arise either from their mutual gravitation toward each other, or from an original projectile force impressed upon them. These two causes are known to act on all the bodies belonging to the solar system, and we may therefore reasonably admit them to exert their influence likewise on the stars. But it will not be sufficient to know a general cause for their mo-

tions,

tions, unless we can show that its influence will tend to make them go toward a certain part of the heavens rather than to any other. Let us examine how these causes are acting in the solar system.

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The projectile motions of the planets, the asteroids, and the satellites, excepting those of the Georgium Sidus, are all decidedly in favour of a marked singularity of direction. We may add to them the comet of the year 1682, whose regular periodical return in 1759 has sufficiently proved its permanent connection with the solar system. Here then we have not less than 23 various bodies belonging to the solar system to show that this cause not only can, but in the only case of which we have a complete knowledge, actually does influence the celestial motions, so as to give them a very particular appropriate direction. Even the exception of the Georgian satellites may be brought in confirmation of the same peculiarity; for though they do not unite with the rest of the bodies of our system, they still conform among each other to establish the same tendency of a similar direction in their motion round the primary planet. And thus it is proved that the similar direction of the motion of a group of stars may be ascribed to their similar projectile motions without incurring the censure of improbability.

Let us however pursue the objection a little farther, and as we have shown that the celestial bodies of the solar system actually have these similar projectile motions, it may be required that we should also prove that the stars have them likewise; since the appearances in Fig. 5 may otherwise be looked upon as merely the consequence of the assumed solar motion. To this I answer, that setting aside the solar motion, and allowing the observations of astronomers on the proper motion of the stars to give us the real direction and angular quantity of these motions, even then the same similarity will equally remain to be accounted for. In my examination of Fig. 1 and 3, it has been shown that we ought to ascribe the similar directions of the sidereal motions to some physical cause, which probably exerts its influence also on the solar motion; therefore in reverting to those figures

I may

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I may be said to appeal to the actual state of the heavens, for a proof of what has been advanced, with respect to the similarity of the directions of projectile motions.

Having thus examined one cause of the sidereal motions, and shown that as far as we are acquainted with its mode of acting in the solar system, it is favourable to a similariy of direction; and that moreover, if we ascribe the motion of the stars to it, we have also good reason, from observation, to believe it to be in favour of the same similarity; we may in the next place proceed to consider the mutual gravitation of the stars toward each other. This is an acknowledged principle of motion, and the laws of its exertion being perfectly known, we shall in this inquiry meet with no difficulty relating to its direction, which is always toward the attracting body.

Considerations of the attractive Power required for a sufficient Velocity of the sidereal Motions.

As attraction is a power that acts at all distances, we ought to begin by examining whether the motions of our stars can be accounted for by the mutual gravitation of neighbouring stars toward each other, or by a periodical binal revolution of them about a common centre of gravity; or whether we ought not rather to have recourse to some very distant attractive centre. This may be decided by a calculation of the effects arising from the laws according to which the principle of attraction is known to act. For instance, let the sun and Sirius be two equal bodies placed in the most favourable situation to permit a mutual approach by attraction: that is, let them be without projectile motions, and removed from all other stars which might impede their progress toward each other, by opposite attractions. Then, by calculation, the space over which one of them would move in a year, were the matter of both collected in the other as an attractive centre, would be less than a five thousand millionth part of a second; supposing that motion to be seen by an eye at the distance of Sirius, and admitting the parallax of the whole orbit of the earth on this star to be one second.

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This proves evidently that the mere attraction of neighbouring stars acting upon each other cannot be the cause of the sidereal motions that have been observed.

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In the case of supposed periodical binal revolutions of stars about a common centre of gravity, where consequently projectile motions must be admitted, the united power of the connected stars, provided the mass of either of them did not greatly exceed that of the sun, would fall very short of the attraction required to give a sufficient velocity to their motions. The star Arcturus, for example, which happens to move, as is required, in an opposite direction to the proposed solar motion, were it connected with the sun, and had the proper degree of necessary projectile motion, could not describe an arch of 1″ of its orbit, about their common centre, in less than 102 years; and though the opposite motion of the sun, by a parallactic effect would double that quantity, it still would fall short of the change we observe in this star in the course of a single year.

Other considerations are still more against the admission of such partial connections: they would entirely oppose the similarity of the directions of the sidereal motions that have been proved to exist, and which we are now endeavouring to explain.

Let us then examine in what manner a distant centre of attraction may be the cause of the required motions. By admitting this centre to be at a great distance, we shall have its influence extended over a space that will take in a whole group of stars, and thus the similar directions of their motions will be accounted for. Their velocities also may be ascribed to the energy of the centre, which may be sufficiently great for all the purposes of the required motions. A circumstance, however, attends the directions of the motions to be explained, which shows that a distant centre of attraction alone will not be sufficient; for these motions, as we may see in Fig. 3, though pretty similar in their directions, still are diverging; whereas if they were solely caused by attraction, they would converge toward the attracting centre, and point out its situation. It is therefore evident that projectile motions must be combined with attraction, and that the motions

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motions of the stars when regulated in this manner, are not unlike the disposition by which the bodies of the solar system are governed. If we pursue this arrangement, it will be proper to consider the condition, and probable existence of such a centre of attraction.

There are two ways in which a centre of attraction, so powerful as the present occasion would require, may be constructed: the most simple of them would be a single body of great magnitude; this may exist, though we should not be able to perceive it by any superiority of lustre; for notwithstanding it might have the usual starry brightness, the decrease of its light arising from its great distance would hardly be compensated by the size of its diameter; but to have recourse to an invisible centre, or at least to one that cannot be distinguished from a star, would be entirely hypothetical, and, as such, cannot be admitted in a discussion, the avowed object of which is to prove its existence.

The second way of the construction of a very powerful centre, may be joint attraction of a great number of stars united into one condensed group.

The actual existence of such groups of stars has already been proved by observations made with my large instruments; many of those objects, which were looked upon as nebulous patches, having been completely resolved into stars by my 40 and 20-feet telescopes. For instance, the nebula discovered by Dr. Halley in the year 1714, in which the discoverer, and other observers after him, have seen no star, I have ascertained to be a globular cluster, containing, by a rough calculation, probably not less than fourteen thousand stars. From the known laws of gravitation, we are assured that this cluster must have a very powerful attractive centre of gravity, which may be able to keep many far distant celestial bodies in control.

But the composition of an attractive centre is not limited to one such cluster. An union of many of them will form a still more powerful centre of gravitation, whose influence may extend to a whole region of scattered stars. To prove that I argue entirely from observations, I shall mention that another nebula, discovered by Mr.

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Mr. Messier in the year 1781, is, by the same instruments, also proved to consist of stars; and though they are seemingly compressed into a much smaller space, and have also the appearance of smaller stars, we may fairly presume that these circumstances are only indications of a greater distance, and that, being a globular cluster, perfectly resembling the former, the distance being allowed for, it is probably not less rich in the number of its component stars. The distance of these two clusters from each other is less than 12 degrees, and we are certain that somewhere in the line joining these two groups there must be a centre of gravitation, far superior in energy to the single power of attraction that can be lodged in either of the clusters.

I have selected these two remarkable objects merely for their situation, which is very near the line of the direction of the solar motion; but were it necessary to bring farther proof of the existence of combined attractions, the numerous objects of which I have given catalogues* would amply furnish me with arguments.

If a still more powerful but more diffused exertion of attraction should be required than what may be found in the union of clusters, we have hundreds of thousands of stars, not to say millions, contained in very compressed parts of the milky way, some of which have already been pointed out in a former paper †. Many of these immense regions may well occasion the sidereal motions we are required to account for; and a similarity in the direction of these motions will want no illustration.

With regard to the situation of the condensed parts of the milky way, and of the two clusters that have been mentioned, we must remark, that the seat of attraction may be in any part of the heavens whatsoever; for when projectile motions are given to bodies that are retained by an attractive centre, they may have any direction, even that at right angles to its situation not excepted.

* Phil. Trans. for 1786, page 457; for 1789, page 212; for 1802, page 477.

† Ibid. for 1802, page 495.

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It will give additional force to the arguments I have used for the admission of far distant centres of attraction, as well as projectile motions in the stars that are connected with them, when we take notice that, independent of the solar motion, and setting that entirely aside, the action of these causes will be equally required to explain the acknowledged proper motions of the stars. For if the sun be at rest, then Arcturus must actually change its place more than 2″ a year, and consequently this and many other stars, which are well known to change their situation, must be supposed to have projectile motions, and to be subject to the attraction of far distant centres.

Determination of the Quantity of the Solar Motion.

If I am not mistaken, it will now be allowed that no objection can arise against any solar velocity we may fix upon, for want of a cause that may be assigned to act upon the sun, and many stars, so as to account for their motions, and similar tendency toward a certain part of the heavens; we may consequently proceed in examining whether the quantity that has been assumed for calculating the contents of the XIth Table, will sufficiently come up to the conditions we have adopted for directing our determination.

In Fig. 6 we have the velocities of the 36 stars delineated, and by examining the last column of the Table from which they are taken, we find that the parallactic effects arising from the proposed solar motion require the velocity of 18 stars to exceed that of the sun, and exactly the same number to be inferior to it; so far then the rank which has been assigned to the solar motion is a perfect medium among the sidereal velocities.

If we examine in the next place how this motion will agree with a mean rate deduced from the velocities in the above mentioned column, we find a 36th part of their sum to be 1196550. A solar motion, therefore, which agrees with this mean rate will differ from one assigned by the middle rank no more than 0″,079558; and, on account of the smallness of this quantity, the calculations required to lessen it, by some little increase of the solar motion,

motion, might well be dispensed with; but if we were desirous of greater precision, the secondary purpose, next to be considered, would rather incline us to an opposite alteration.

Investigation of the proper motion of the sun.

The great disparity of the sidereal motions, which has been mentioned as an incongruity in the first part of this Paper, and has more evidently been shown to exist when we examined the representations of these motions in the 3d figure, is the next point we have to consider in the effect of the solar motion. Let us see how far we have been successful in lessening the ratio these velocities bear to each other. The last column of the Xth Table contains them as they must have been admitted if the sun had been at rest. The proportion of the quickest motion to the slowest is there as 2504621 to 103036; and the velocity of one is therefore above 24 times greater than that of the other. But in consequence of the solar motion we have used, the two extreme velocities are reduced to 2902716 and 395212; which gives a proportion of less than $7\frac{1}{2}$ to 1.

If the quantity of the solar motion were lessened to $1''$, we might bring the ratio of the extreme velocities so low as 6 to 1; but as the middle rank has already given it a little below the mean rate, I do not think that we ought to lower it still more; so that when all circumstances are properly considered, there is a great probability that the quantity assumed in the last calculation may not be far from the truth. It appears, therefore, that in the present state of our knowledge of the observed proper motions of the stars, we have sufficient reason to fix upon the quantity of the solar motion to be such as by an eye placed at right angles to its direction, and at the distance of Sirius from us, would be seen to describe annually an arch of $1''$,116992 of a degree; and its velocity, till we are acquainted with the real distance of this star, can therefore only be expressed by the proportional number of 1116992.

Concluding Remarks and Inferences.

We have now only to notice a few remarks that may be

 made,

Investigation of the proper motion of the sun.

made, by way of objection to the solar motion I have fixed upon. If the quantity of this motion is to be assigned by the mean rank of sidereal velocities, it may be asked, will not the addition of every star, whose proper motion shall be ascertained, destroy that middle rank, which has been established? To this I shall answer, that future observations may certainly afford us more extensive information on the subject, and even show that the solar motion should not exactly hold that middle rank, which from various motives we have been induced to assign to it; but at present it appears, that according to the doctrine of chances, a middle rank among the sidereal velocities must be the fairest choice, and will remain so, unless, what is now a secondary consideration, should hereafter become of more importance than the first. That this should happen is not impossible, when a general knowledge of the proper motions of all the stars of the 1st, 2d, and 3d magnitudes can be obtained; but then the method of calculation that has been traced out in this and the former Paper, is so perfectly applicable to any new lights observation may throw upon the subject, that a more precise and unobjectionable solar motion can be ascertained by it with great facility. Hitherto we find that a mean rank agrees sufficiently with the phenomena that were to be explained: the apparent velocities of Arcturus and Aldebaran, without a solar motion for instance, were to each other, in the IXth Table, as 208 to 12; our present solar motion has shown, that when the deception arising from its parallactic effect is removed by calculation, these velocities are to each other only as 179 to 85, or as 2 to 1. And though Arcturus still remains a star that moves with great velocity, yet in the XIth Table we have 4 or 5 stars with nearly as much motion; and 4 with more.

Our solar motion also removes the deception by which the motion of a star of the consequence of α Orionis is so concealed as hardly to show any velocity; whereas by computation we find that it really moves at a rate which is fully equal to the motion of the sun.

I must now observe, that the result of calculations founded upon facts, such as we must admit the proper motions

motions of the stars to be, should give us some useful information, either to satisfy the inquisitive mind, or to lead us on to new discoveries. The establishment of the solar motion answers both these ends. We have already seen that it resolves many difficulties relating to the proper motions of the stars, and reconciles apparent contradictions; but our inquiries should not terminate here. We are now in the possession of many concealed motions, and to bring them still more to light, and to add new ones by future observations should become the constant aim of every astronomer.

Investigation of the proper motion of the sun.

This leads me to a subject, which though not new in itself, will henceforth assume a new and promising aspect. An elegant outline of it has long ago been laid before the public in a most valuable paper on general Gravitation, under the form of "Thoughts" on the subject*; but I believe, from what has been said in this Paper, it will now be found that we are within the reach of a link of the chain which connects the principles of the solar and sidereal motions with those that are the cause of orbitual ones.

A discovery of so many hitherto concealed motions, presents us with an interesting view of the construction of that part of the heavens which is immediately around us. The similarity of the directions of the sidereal motions is a strong indication that the stars, having such motions, as well as the sun, are acted upon by some connecting cause, which can only be attraction; and as it has been proved that attraction will not explain the observed phenomena without the existence of projectile motions, it must be allowed to be a necessary inference, that the motions of the stars we have examined are governed by the same two ruling principles which regulate the orbitual motions of the bodies of the solar system. It will also be admitted that we may justly invert the inference, and from the operation of these causes in our system, conclude that their influence upon the sidereal motions will tend to produce a similar effect; by which means the probable motion of the sun, and of the stars in

* See the note Phil. Trans. for 1783, page 283.

orbits,

Investigation of the proper motion of the sun.

orbits, becomes a subject that may receive the assistance of arguments supported by observation.

What has been said in a paragraph of a former Paper, where the sun is placed among the insulated stars *, does not contradict the present idea of its making one of a very extensive system. On the contrary, a connection of this nature has been alluded to in the same Paper†. The insulation ascribed to the sun relates merely to a supposed binary combination with some neighbouring star; and it has now been proved by an example of Arcturus, that the solar motion cannot be occasioned or accounted for by a periodical revolution of the sun and this or any other star about their common centre of gravity.

III.

Explanation of a common Impurity in the Nitrate of Ammonia, which interferes with the production of Nitrous Oxide. By Mr. John Sadler.

Unexpected ebullition and expansion of the nitrate of ammonia.

In attempting to procure nitrous oxide from nitrate of ammonia by heat, it has frequently happened, when I expected the salt to be at the point of decomposition, and nitrous oxide about to be formed, a violent ebullition has taken place, and dense white fumes have been disengaged so rapidly as frequently to burst the retort. When first I observed the fact, I imagined too great a degree of heat had been employed, and the nitrate of ammonia rapidly sublimed and carried over with the nitrous oxide. In my subsequent attempts I endeavoured to guard against the possibility of falling into the same error by increasing the heat gradually and interposing a plate of iron between the bottom of the retort and the furnace when I supposed the heat too intense; yet, notwithstanding these precautions, the same rapid disengagement of dense white

It did not arise from excess of heat.

* See the note Phil. Trans. for 1802, page 478.

† Phil. Trans. for 1802, page 479.

vapours

vapours took place, and continued for a considerable time after the retort had been removed from the fire. The residue in the retort scarcely ever exhibited the same phenomena upon being again subjected to the same treatment; but nitrous oxide was always produced without any farther trouble.

Having frequently procured nitrous oxide without any of the phenomena I have described, I suspected the nitrate of ammonia I had been operating on was impure. I made an examination of the salt, and found it contained a portion of muriate of ammonia. To ascertain whether the muriatic acid had been the cause of the rapid disengagement of white vapour, I took a portion of the same kind of salt I had before made use of, and freed it perfectly from muriatic acid by means of nitrate of silver. The purified salt I introduced into a retort, and proceeding in the usual way, obtained pure nitrous oxide without any of the dense white vapour.

Suspected impurity.

It was muriate of ammonia.

To assure myself the presence of the muriatic acid had been the occasion of the facts I observed, I made some pure nitrate of ammonia by the direct combination of pure nitric acid and carbonate of ammonia. I took two portions of the solution, and to one of them added a solution of muriate of ammonia. The two solutions were then crystallised, an equal quantity of each salt was exposed to the heat of an Argand lamp, in glass retorts communicating with the pneumatic trough; the retort containing the compound salt gave out very rapidly a dense opake elastic fluid similar to the white vapours first described; after a short time the evolution of gas became considerably less abundant, and the interior of the retort became clear; the receiver was then changed; upon examination, what came over now was nearly pure nitrous oxide.

Proof by direct experiment.

The first portions of the gas evolved, that is the opake gas, had the following properties:

Properties of the opake gas obtained from the impure salt,

1st. It remained opake after being passed through cold water.

2nd. A slip of paper coloured blue by tincture of turnsole, when immersed in the gas was changed to red.

3rd. It is not inflammable.

4th. A

4th. A lighted taper is immediately extinguished by immersion in it.

5th. It has a disagreeable acidulous taste, and pungent smell, in which the peculiar odour of nitro-muriatic acid gas is perceptible.

6th. An equal bulk of water did not seem to dissolve any very considerable portion of this gas.

Pure nitrate gives much more of the oxide.

The retort containing the pure nitrate, exposed to the same degree of heat, gave out very soon pure nitrous oxide; but considerably more in quantity; I think considerably above a third more.

It may be observed from what I have detailed, that the presence of muriatic acid is of considerable disadvantage in nitrate of ammonia, when intended for the production of nitrous oxide, the process being rendered by it so much more troublesome, and the quantity of oxide so much less than what is obtained from an equal quantity of pure salt.

I have not observed how small a quantity of muriate affects the process, but considerably under $\frac{1}{8}$ is sufficient to make a disagreeable interruption in the operation.

Farther experiments still wanting.

Many experiments are wanting to point out the peculiar nature of the gas first produced by the decomposition of the impure salt; an examination may probably tend to throw some more light upon the nature of affinities. The subject I think is worth pursuing; at present I have neither the time nor means to give it a farther examination; at some future period I may proceed farther, unless some abler person should take it in hand.

IV.

On the Absorption of Electric Light by different Bodies. In a Letter from Mr. WM. SKRIMSHIRE, Jun. *to* Mr. CUTHBERTSON, *Philosophical Instrument Maker, Poland Street, Soho. Communicated by Mr. Cuthbertson.*

DEAR SIR,

IF you think any of the following facts worthy of publicity, you are at liberty to make what use you please of them.

You know that if a shock be passed through or over the surface of a lump of sugar, the electric light is absorbed, and the sugar becomes luminous. This circumstance induced me to try if other substances did not possess the same property, and with this view I have undertaken a course of experiments, beginning with the calcareous substances, which genus I have already gone through as far as circumstances would permit me. Whether or not the same thing has been undertaken by others I do not know, but as far as my reading enables me to decide, I think it has not; at least with the sole view to the phosphorescence of these substances systematically pursued, the path is clearly untrodden. Electric light renders sugar luminous.

My mode of making the experiments was as follows:

I placed the substance to be tried on a brass plate, which, by means of a piece of thick wire, was fixed horizontally on the knob of the prime conductor, and endeavouring to take the spark from it by means of the ball of the discharger. It was afterwards placed upon a table, or wooden stand, and the shock from a Leyden phial, first passed over it about a quarter or half an inch above its surface, by resting the points of the discharging rods at an inch or more distance from each other, upon the stone to be tried. It need scarcely be observed that in the following experiments it is necessary to close the eyes until the explosion be heard. Some of the results were very beautiful and curious. New experiments.

All the calcareous species which I tried were more or less

Calcareous spars very luminous by the electric shock,

less phosphorescent, and the sparks taken along the surface of a piece of rhombic spar was reflected so intensely as to illuminate the whole table with a brilliant white light.

— particularly chalk.

Amongst the aerated species, common chalk was extremely luminous when the shock was passed at some distance above it, and when passed along its surface the fluid left a very vivid zig-zag track of light, which continued for several minutes.

Ketton stone.

Next to chalk in its phosphoric appearances was a stone called Ketton stone, which consists of large distinct grains, agglutcd together like the roes of fish; in passing the shock along its surface, some portion of the stone was shattered, and its luminous grains dispersed in all directions.

Other bodies.

Amongst the several varieties of the sulphate of lime, the specular gypsum, or selenite, is by far the most beautifully phosphoric, but at the same time its light is much more evanescent than in other substances which are less luminous. An oblong six-sided prism of specular selenite shone by the electric explosion with a vivid greenish light, but it continued a very few seconds only. Nitrate of lime fresh made, and tried whilst yet warm, gave small sparks, which upon the surface of the nitrate were quite red, or rather flame-coloured, and it absorbed the electric light but slightly. Muriate of lime was somewhat more phosphorescent than the nitrate. All the fluates absorbed the light freely; the dark purple fluor spars afforded no spark, but allowed the electric fluid to pass in a purple stream, accompanied with a whizzing noise, whilst a yellowish fluor, and another with a greenish tint, which was phosphoric by heat, afforded very good sparks.

Sulphuret of lime particularly luminous.

Sulphuret of lime, commonly called Canton's phosphorus, is much the most luminous by the electric explosion of any substance I have hitherto tried, and affords some beautiful experiments, one of which I cannot help mentioning.

Striking and beautiful experiments.

Mix sulphate of lime with the white of an egg, and spread it about the tenth of an inch thick upon a piece of board; dry it in the air for a day or two (as it dries very slow),

slow), and when perfectly dry it is very hard; place the ends of the discharging rods upon this substance, about two inches asunder, and take the explosion of a Leyden phial. The fluid does not pass over the surface of the sulphuret quietly, but strips it from the board, and disperses it with violence in every direction, giving the appearance of a beautiful shower of fire.

Phosphate of lime.

Phosphate of lime. All the bones which I have tried are luminous by the absorption of electric light, and the enamel of the teeth is still more so; ivory is very phosphorescent by the explosion, and readily perforated by it. The shock from a small phial will perforate from nine to twelve ivory fansticks, and the spark renders these thin slips of ivory transparent. Phosphoret of lime gives a very minute red spark, and is but slightly phosphorescent when the explosion is made above its surface.

—is inflammable by a very small shock.

But its most remarkable property is that of being inflammable by means of a very small shock passed through it. As the flame is readily extinguished, a very small piece of the phosphoret, about half the size of a filbert, may be set on fire several times.

I have tried many of the testacea and lithophyta, and considering the facility with which all of them imbibed the electric light, I suspect it is a general property belonging to those tribes. The same may be said of all extraneous fossils, which are of a calcareous nature.

Quick lime is not rendered luminous.

Considering how beautifully luminous calcined oyster shells and belemnites are rendered by the electric explosion, I was much surprised to find quick lime fresh from the kiln rank amongst the least phosphorescent of the calcareous genus. Besides the substances here individually specified, I have tried several of the marbles, limestones, stalactites, and spars, all of which were phosphoric.

Should any thing curious occur in my trials with the remaining genera, I shall not fail to inform you, if you think this communication worth acceptance.

I remain your's, &c.

WM. SKRIMSHIRE, JUN.

Wisbech, Oct. 16, 1806.

V.

Description of a Portable Blow Pipe for Chemical Experiments. By W. H. Wollaston, *M.D. Sec. R.S. &c.*

To Mr. Nicholson.

Sir,

Pocket blow pipe.

THE consideration of those instruments which facilitate the attainment of chemical knowledge cannot be thought foreign to the design of a Journal which professes to have for one of its objects the diffusion of chemical information; I am in hopes, therefore, that a short description of a portable pocket blow pipe may be acceptable to many of your readers.

Two tubes slide and draw out, &c.

It consists of three parts, so adapted to each other that they may either be packed together, one within the other, as in Fig. 1. Pl. VIII. which represents them of their actual size, or they may be connected for use, as in Fig. 2. in which the whole is reduced to one half of its real dimensions.

In Fig. 1. the interior tube is shewn to be longer than the exterior; and it is made so, that it may be more readily withdrawn.

In each figure, the upper edge of the large end appears turned outward, in order to diminish the effort of the lips requisite for retaining it in the mouth.

In Fig. 2. it will be seen that the small extremity is placed obliquely (at an angle of about 120°), with the design that the flame impelled by it may be carried to a more convenient distance from the eye, so as to answer the purpose of a longer blow pipe.

This oblique piece is itself composed of three parts, of which the largest is made stronger than the rest of the blow pipe, that it may not be strained by frequent use. One end of this is closed, and into the other is inserted a small peg of wood, perforated so as to receive the tip, which is intended to be occasionally separated, for the purpose of passing a fine needle into it to remove any accidental obstruction.

The

The intention of interposing the piece of wood in this place is, to prevent the communication of heat, which might be inconvenient to the hand that holds the blow pipe.

I remain, Sir,
Your obliged servant,
WM. H. WOLLASTON.

The blow pipe was made by Holtzapfel, Long Acre.

VI.

Experiments on the Growth of White-Thorn. *By* SAM. TAYLOR, *Esq. of Moston, near Manchester**.

O THE SOCIETY OF ARTS, &c.

Gentlemen,

EVERY one of you, I think, will allow that fences are material objects to be attended to in agriculture; you must also be convinced that there is no plant in this kingdom of which they can so properly be made as the Cratægus Oxyacantha Linnæi, or common White Thorn. In consequence of my being convinced of this, I have been induced to make a few experiments to effect the better propagation of that valuable plant; the result of which, along with specimens of my success, I beg leave to submit to your inspection.

The most valuable fences are made of the white thorn.

In the year 1801, I had occasion to purchase a quantity of thorns, and finding them very dear, I was determined to try some experiments, in order if possible to raise them at a less expense. I tried to propagate them from cuttings of the branches, but with little or no success. I likewise tried if pieces of the root would grow; and I cut from the thorns which I had purchased, about a dozen of such roots as pleased me, and planted them in a border along with those I had bought. To my great astonishment, not one of them died; and in two years they became as good thorns as the average of those I had

Experiments for its propagation.

Cuttings of the branches did not grow; those from the roots did.

* Society of Arts, Vol. XXIII.

Plants of the white thorn successfully propagated from cuttings of the roots.

had purchased. The thorns I purchased were three years old when I got them. In April 1802, I had occasion to move a fence, from which I procured as many roots of thorns as made me upwards of two thousand cuttings, of which I did not lose five in the hundred.

In the spring of 1803, I likewise planted as many cuttings of thorn roots as I could get. In 1804, I did the same; and this year I shall plant many thousands.

I have sent for your inspection specimens of the produce of 1802, 1803, and 1804, raised after my method, with the best I could get of those raised from haws in the common way, which generally lie one year in the ground before they vegetate. They are all exactly one, two, and three years old, from the day they were planted. I was so pleased with my success in raising so valuable an article to the farming interest of this kingdom, at so trifling an expense, (for it is merely that of cutting the roots into lengths and planting them,) that I was determined to make it known to the world, and could think of no better method than commnnicating it to your Society; and should you so far approve of this method of raising thorns, as to think me entitled to any honorary reward, I shall receive it with gratitude, but shall feel myself amply repaid for any trouble I have been at, should you think it worthy a place in the next volume of your Transactions.

The method of raising the thorns from roots of the plant, is as follows:

I would advise every farmer to purchase a hundred or a thousand thorns, according to the size of his farm, and plant them in his orchard or garden, and when they have attained the thickness of my three-year-old specimens, which is the size I always prefer for planting in fences, let him take them up and prune the roots in the manner I have pruned the specimen sent you, from which he will upon an average get ten or twelve cuttings from each plant, which is as good as thorns of the same thickness; so that you will easily perceive that in three years he will have a succession of plants fit for use, which he may if he pleases increase ten-fold every time he takes them up.

The spring (say in all April) is the best time to plant the

the cuttings, which must be done in rows half a yard asunder, and about four inches from each other in the row; they ought to be about four inches long, and planted with the top one-fourth of an inch out of the ground, and well fastened: otherwise they will not succeed so well.

Plants of the white thorn successfully propagated from cuttings of the roots.

The reason why I prefer spring to autumn for planting the roots, is, that were they to be planted in autumn, they would not have got sufficient hold of the ground before the frost set in, which would raise them all from the ground, and, if not entirely destroy the plants, would oblige the farmer to plant them afresh.

I have attached the produce of my three-year-old specimen to the plants it came from, cut in the way I always practise; on the thick end of the root I make two, and on the other end one cut, by which means the proper end to be planted uppermost, which is the thick one, may easily be known.

Although I recommend the roots to be planted in April, yet the farmer may, where he pleases, take up the thorns he may want, and put the roots he has pruned off into sand or mould, where they will keep until he has leisure to cut them into proper lengths for planting; he will likewise keep them in the same way, until planted.

The great advantage of my plan is: first, that in case any one has raised from haws, a thorn with remarkably large prickles, of vigorous growth, or possessing any other qualification requisite to make a good fence, he may propagate it far better and sooner, from roots, than any other way. Secondly, in three years he may raise from roots a better plant, than can in six years be raised from haws, and with double the quantity of roots; my three-year-old specimen would have been half as big again, had I not been obliged to move all my cuttings the second year after they were planted.

It would not be a bad way, in order to get roots, to plant a hedge in any convenient place, and on each side trench the ground two yards wide, and two grafts deep; from which, every two or three years, a large quantity of roots might be obtained, by trenching the ground over again, and cutting away what roots were found, which

Planks of the white thorn successfully propagated from cuttings of the roots.

which would all be young and of a proper thickness. I do not like them of a larger size than the specimens sent.

I am at present engaged in several experiments, to endeavour to propagate the thorn from the branches, which, if successful, I will communicate to you; but I am of opinion, that what is now done is sufficient.

Should the Society require any further explanations, I shall be happy in doing my utmost to furnish such explanations*.

SAMUEL TAYLOR.

Moston, near Manchester,
May 6th, 1805.

VII.

On the Phantasms produced by Disordered Sensation. In a Letter from a Correspondent.

To Mr. Nicholson.

Sir,

Spectres seen by Nicolai from nervous indisposition.

I HAVE just been perusing in your Journal for Nov. 1803, the Memoir of Nicolai, on spectres which haunted that intelligent and estimable man for two months. His narrative developes many curious topics of investigation, respecting our perceptions, and may perhaps lead to a farther explanation of the laws by which our trains of ideas are governed, and the mechanism of our organs of thought; concerning which, so little is known. The perusal induces me to send you a few more facts relative to the same obscure subject.

These phenomena are by no means uncommon.

Many persons, particularly females, within the circle of my personal knowledge, have related to me incidents of the same nature, arising from nervous indisposition. Nothing is more common than the appearance of figures and sounds in fevers; and they are very frequently exhibited to persons in apparent good health. In all the instances related to me, the parties were aware of the objects

* Specimens were sent to the Society.

objects being the mere consequences of indisposition, or what may be called internal sensation, and spoke of them as such. It is not a month since I was sitting alone with a lady, for whose powers of mind and moral habits, I have the highest respect, when after a short and sudden pause, she said—"This moment I saw M——— standing in "his usual manner just behind your chair, and a little "while afterwards he was in the corner of the room:" Upon my inquiring respecting the appearance, she said the figure was paler, or less clearly visible, than usual, and that it gradually faded away.

Account of an instance.

I know a gentleman, at present in the vigor of life, who in my opinion is not exceeded by any one, in acquired knowledge, and originality of deep research; and who, for nine months in succession, was always visited by a figure of the same man, threatening to destroy him, at the time of going to rest. It appeared upon his lying down, and instantly disappeared when he resumed the erect posture. This was not related to me by himself, but by another friend, and his absence has since prevented my inquiring farther.

Phantasm which appeared for many months on lying down to rest.

Little doubt remains in my mind, that many of the stories of apparitions, which have been in all ages so generally received, were true, though probably incorrect, from the influence of the imagination under an impression of terror. When I was a boy, I once or twice in the night awoke with the disease commonly called the night-mare; and then the fit was accompanied with a sense of weight, as if caused by a person actually pressing on me, and touching me with cold hands; and in the momentary interval between one crisis and the next, I had a consciousness that that person hurried round the room and came back to torment me again, before I could recover my speech or motion. But afterwards, when I was older and considered these as the effects of disease, I had an attack, in which I experienced no terror, nor had any concomitant notion of an external agent; and as soon as I felt a remission of the rigor, I sprung up and was relieved; no other consequence remaining but a slight tremor of the surface of the body.

Many of the stories of apparitions have been true; but originated in disease, assisted by fancy.

Incubus, or Night-mare.

About twelve years ago, I had an attack of fever, arising

Narrative of the phantasms

produced by disordered sensation in fever.

sing from some deep seated inflammation which caused acute pain in the left side. It was occasioned by a cold caught at the breaking up of the hard frost in the Spring of 1795. The pulse was generally about 110 in the minute, and the illness, which lasted some weeks, was accompanied with disordered perception, through almost its whole duration. My recollections of what then happened, renewed by occasional meditation on the subjects since that time, are now so far impaired, that some of the particulars recur in a less striking manner; the exact order of their succession, and time of their respective duration, are less certain than these would have been, if my first intention of writing down the various phenomena soon after the event, had been carried into effect.

The disorders of perception form a subject of interest, where a law of action can be indicated.

The phantasms or delusions which accompany and mark disordered sensation, (which term I would use in contradistinction to disorder in the powers of memory reasoning or the moral habits) are perhaps too frequent and too little varied, to afford much interest in describing them, unless where the narrative can point out some law which the effects may seem to follow, or may afford some general inferences that may prove valuable as rules of conduct under such sufferings. It must no doubt be a considerable advantage and consolation to those who might ascribe these visions to supernatural powers, or who might be driven to insanity by impatience or terror, on the supposition of reality, for want of knowing these phenomena of disease;—it must, no doubt be highly beneficial that they should have such knowledge: but the events I offer to your readers, are, in my opinion, principally remarkable for a certain connection they shewed with that common law of association, by which our usual train of ideas is so immediately and rapidly governed.

Patients may derive much advantage from being aware of the phenomena.

Commencement. Slight but not permanent defect of memory.

At the commencement of the fever, a slight defect of memory was perceived in forming the phrases for dictating a letter; but this did not last, and I found no difficulty afterwards in performing arithmetical and other processes by memory to as great an extent as my usual habits could have gone. The first night was attended with great anxiety, and the fatiguing and perpetual recurrence of the same dream. I supposed myself to be in the

the midst of an immense system of mechanical combination, all the parts of which were revolving with extreme rapidity and noise, and at the same time I was impressed with a conviction that the aim or purpose of this distracting operation was to cure my disorder. When the agitation was carried to a certain height, I suddenly awoke, and soon afterwards fell again into a doze, with repetition of the same dream. After many such repetitions it occurred to me that if I could destroy the impression or conviction, there might be a probability that the delirious dream would change its form; and as the most likely method, I thought that by connecting some simple visible object in my mind, with the notion of cure, that object might be made to occupy the situation of the rapidly moving objects in the dream. The consequence, in some measure, answered my expectation; for upon the next access, the recollection of the figure of a bottle, to which I had previously directed my mind, presented itself, the rotation ceased, and my subsequent dreams, though disturbed, were more various and less irritating.

Anxiety: incessant recurrence of the same dream.

This recurrence was prevented by an act of discipline in the mind.

The medical treatment consisted in the external application of leeches to the side, with venesection, and the saline mixture was taken internally.

Medical treatment.

A second night was passed with much agitation in repeated dozing, with dreams, in which, except with regard to the strangeness and inconsistency of the objects that offered themselves, it was difficult to distinguish the time of sleep from that of wakefulness. None of that anxiety of mind remained which had added to the sufferings of the preceding night. When morning came, the state of the sensations had either undergone a change; or it was more easy, as Hartley* remarks, for the real impressions of surrounding objects, to predominate over the phantasms of disease. Being perfectly awake, in full possession of memory, reason and calmness, conversing with those around me, and seeing, without difficulty or impediment, every surrounding object, I was entertained and delighted with a succession of faces, over which I had no control, either as to their appearance, continuance or removal.

Disturbed night:—

—and in the morning, a succession of phantasms of faces succeeding each other for a long time.

* On Man.

Manner of their appearance, duration and change.

They appeared directly before me, one at a time, very suddenly, yet not so much so, but that a second of time might be employed in the emergence of each, as if through a cloud or mist, to its perfect clearness. In this state each face continued five or six seconds, and then vanished, by becoming gradually fainter during about two seconds, till nothing was left but a dark opake mist, in which almost immediately afterwards appeared another face. All these faces were in the highest degree interesting to me, for beauty of form and the variety of expression they manifested of every great and amiable emotion of the human mind. Though their attention was invariably directed to me, and none of them seemed to speak, yet I seemed to read the very soul which gave animation to their lovely and intelligent countenances: admiration and a sentiment of joy and affection when each face appeared, and regret upon its disappearance, kept my mind constantly rivetted to the visions before it; and this state was interrupted only when an intercourse with the persons in the room was proposed or urged.

Theory of Hartley; that the visions of fever are common ideas or thoughts exalted by irritability.

It was in my recollection that Hartley in his work upon Man adopts a theory, that the visions of fever are common ideas of the memory recalled in a system so irritated, that they act nearly with the same force as the objects of immediate sensation, for which they are accordingly mistaken: and therefore it is, says he, that when delirium first begins, if in the dark, the effect may be suspended by bringing in a candle, which by illumination gives the due preponderance to the objects of sense. This, however, I saw was manifestly unfounded. It was

It is not the fact.

in my power to think of absent objects (e. g. of sight) as usual, but they did not appear. The ideas were in the mind as usual, and at the very same time, the real objects of sense, and the objects of diseased sensation stood visible before me.

Ideas, sensations and phantasms can be all distinctly present at once.

When my attention was strongly fixed on the idea of an absent place or thing, the objects of sensation and of delirium were less perceived or regarded. When the mind was left in a passive or indolent state, the objects of delirium were most vivid, and the objects of sensation, or real objects in the room, could not be seen. But

But when by a sort of exertion, the attention was roused, the phantasms became as it were transparent, and the objects of sensation were seen as if through them. There was not the least difficulty in rendering either object visible at pleasure; for the phantasms would nearly disappear, while the attention was steadily fixed on the real objects. Each particular phantasm was neither hastened nor retarded in its whole appearance or duration by this process.

The voluntary attention of the mind, gives vigour and strength to either of the three, at pleasure.

After a morning passed in this manner, I had a visit from Dr. C——, to whom I related the effects, and among other remarks I observed that I then enjoyed the satisfaction of having cultivated my moral habits, and particularly in having always endeavoured to avoid being the slave of fear. "I think," said I, "that this "is the breaking up of the system, and that it is "now in progress to speedy destruction. In this state, "when the senses have become confused, and no longer "tell me the truth, they still present me with pleasing "fictions, and, my sufferings are mitigated by that calm-"ness which allows me to find amusement in what are "probably the concluding scenes of life."

Advantages of self-command, conversed upon.

I give these self-congratulations without scruple, because I am an anonymous writer, and more particularly because they led to an observation of fact, which deserves notice. When the doctor left me, my relaxed attention returned to the phantasms, and some time afterwards, instead of a pleasing face, a visage of extreme rage appeared, which presented a gun at me and made me start; but it remained the usual time and then gradually faded away.

The phantasms are affected by the conversation.

This immediately shewed me the probability of some connection between my thoughts and these images; for I ascribed the angry phantasm to the general reflection I had formed in conversation with Dr. C———. I recollected some disquisitions of Locke in his Treatise on the Conduct of the Mind, where he endeavours to account for the appearance of faces to persons of nervous habits. It seemed to me, as if faces, in all their modifications, being so associated with our recollections of the affections or passions, would be most likely to offer themselves in delirium: but I now thought it probable that other objects would

And this suggested a connection between the thoughts and the visionary appearances.

Attempt to

alter the appearance of the phantasms,

would be seen if previously meditated upon. With this motive it was that I reflected upon landscapes and scenes of architectural grandeur, while the faces were flashing before me; and after a certain considerable interval of time, of which I can form no precise judgment, a rural scene of hills, vallies and fields appeared before me, which was succeeded by another and another in ceaseless succession; the manner and times of their respective appearance, duration and vanishing being not sensibly different from those of the faces. All the scenes were calm and still, without any strong lights or glare, and delightfully calculated to inspire notions of retirement, peace, tranquillity and happy meditation. I do not remember how long these lasted, but think it was the next morning that they all vanished, at the very instant of taking a draught, composed of lemon juice, saturated with potash, with a small addition of the pulvis londinensis. I cannot think the effect was owing to any peculiar virtue of this medicine (for it took place before the draught had actually entered the stomach) but merely to the stimulus of the subacid cold fluid.

—which succeeded.

They disappear at the instant of taking a medicine:—

—but return again, though in other forms.

How long the appearances were suspended, I did not note, or have now forgotten. The fever continued with the same frequency of pulse, and pain in the side, attended with yawning and great increase of suffering while in the prone posture. Notwithstanding the saline antimonial medicine was continued, the figures returned; but they now consisted of books, or parchments, or papers containing printed matter. I do not know whether I read any of them, but am at present inclined to think they were either not distinctly legible or did not remain a sufficient time before they vanished. I was now so well aware of the connection of thought with these appearances, that by fixing my mind on the consideration of manuscript instead of the printed type, the papers appeared, after a time, only with manuscript writing; and afterwards by the same process, instead of being erect, they were all inverted or appeared upside down.

—which were changed by volition.

Delusions of the sense of hearing.

It occurred to me that all these delusions were of one sense only; namely, the sight; and upon considering the recurrence of sounds, a few simple musical tones were afterwards

afterwards heard, for one time only; soon after which, having dropped asleep, an animal seemed to jump upon my back, with the most shrill and piercing screams, which were too intolerable for the continuance of sleep.

Another mode of delusive perception of visible objects.

Diseased perceptions of the hearing did not again recur, and I do not remember by what gradation it was, that the frequently changing appearances, before the sight, gave place to another mode of delusive perception, which lasted for several days. All the irregularly figured objects, such as the curtains or clothes, were so far transformed that they seemed to afford outlines of figures, of faces, animals, flowers and other objects, perfectly motionless, somewhat in the manner of what fancy, if indulged, may form in the clouds or in the cavity of a fire; but much more complete and perfect, and not to be altered by steady observation or examination. They seemed to be, severally, as perfect as the rest of the objects with which they were combined, and agreed with them in colour and other respects.

I can make so few inferences or observations upon the several other characters, which these diseased sensations assured, that I shall not attempt to describe them.

Various accounts of ocular facts.

Various authors have given narratives which coincide with the preceding, in part; and as analogy is the great clue for investigating the phenomena of nature, I will give a few facts and remarks which may bring us more to a point.

Phantoms of real objects produced by emotion of mind.

None of the phantoms in my illness were of known places, objects or persons. But on another occasion, when I accidentally fell into the sea, and after swimming a certain time without assistance, began to despair of my situation; the image of my dwelling and the accustomed objects appeared with a degree of vividness, little different from that of actual vision. Mr. Sturt, M. P. when greatly in danger some years ago, by being wrecked in a boat, on the Edystone rocks, relates, in an account which appeared in the papers, that his family appeared to him in this extremity. "He thought he saw them." I think both these instances are referable to Hartley's Theory. The illusions of figures appearing to persons near death are very common.

Sleep

Delirium precedes sleep.

Sleep is, I think invariably preceded by a diminished power of judgment and the appearance of phantasms.

Dreams are like the phantasms of fever.

The objects of dreams appear to be of the same class, or description, as those I had in fever. Like them they appear uncontroled by the will for the moment, and resemble the objects for sense; and like them they can be often traced to some preceding thought or incident. Is not a certain degree of debility one of the conditions required for the appearance of these phantasms?

Comparison of the visible and audible perceptions caused by disease.

The ear is much more an instrument of terror than the eye. Diseased perceptions of sight are more common than those of hearing, and they are in general borne with more tranquillity. A few simple sounds usually constitute the amount of what the ear unfaithfully presents; but when incessant half-articulated whispers, sudden calls, threats, obscure murmurs, and distant tollings are heard, the mind is less disposed to patience and calm philosophy. Instances however are not wanting, in which musical combinations of enchanting melody haunt the mind, and occupy the senses of those who are oppressed with indisposition.

I will not make this letter longer by apology. Do with it what you please, and I shall continue,

A grateful sharer
In your labours.

L. M.

VIII.

Early Account of the Bath Waters, by JOHN MAYOW. *Extracted in a Letter from* W. R. CLANNY, *M.D. Hon. Member of the Royal Philos. Soc. at Edinburgh, Senior Physician to the Durham Infirmary.*

To MR. NICHOLSON.

BEING lately much engaged in the interesting study of mineral waters, amongst other books on the subject I read with much pleasure a scarce work, entitled, "A Discourse of Bathe, and the Hot Waters there, &c. by Tho. Guidott, M. B. London, 1676." The author has inserted

inserted a translation of Dr. Mayow's Analysis of the Bath Waters, for the purpose of refuting it; and in his zeal to support his own analysis, in which he asserted that the Bath Waters contained nitre and sulphur, he has preserved Dr. Mayow's analysis, which, even at this enlightened period of chemical science, must be esteemed as a superior production. On reading it I was impressed with the idea that it would be interesting to many of your scientific readers, who may not have seen the work I allude to. Early examination of the Bath waters.

How far Dr. Mayow understood the oxydation of metals his own words will shew; nor will any unprejudiced reader suppose that the thread of science was broken in his hand.

Dr. Mayow's Analysis was published in the Latin language, which I have not seen; but it is rather an advantage to general readers to have a translation in the vernacular language, and being translated by a cotemporary, though a rival Physician, may in some degree assist in fixing our ideas of the meaning of the author.

Since writing the above, Dr. Gebbes' excellent analysis of the Bath Waters has come to hand; his judicious remarks on Dr. Mayow's Analysis preclude me from offering any further observations, except, that by Dr. Mayow's Analysis I was led to understand that the Bath Waters contained iron in a pure state, which is since corroborated by Dr. Gibbes' late communication to your excellent Journal. I shall now give the whole chapter from Mr. Guidott's work, wherein is inserted Dr. Mayow's Analysis.

CHAP. II.

" *The Opinion of a late Author concerning the Nature of the Baths of Bathe.* Joh. Mayow, L.L.D. & M.D.

" And here I cannot but take notice of a novel writer, who magesterially thus determines: *Quod ad nitrum et sulphur attinet, quibus Thermas Bathonienses imbutas esse hactenus creditum est, eorum neutrum aquis thermarum istarum solutum esse arbitror: As to what concerns nitre and sulphur with which the Baths of Bathe have hitherto*

Early examination of the Bath waters.

hitherto been thought to be impregnated, I suppose there is nothing of either of them dissolved in the waters.

"A bold assertion! which had it been vented and believed but fifty years ago, would have prevented much trouble in evincing the contrary; but since 'tis the fashion to be peremptory, I do assert, *That both nitre and sulphur are to be found in all the baths of Bathe, and that dissolved in, and mixed with, the body of the waters.* In order to the proof of which I shall take some account of the forementioned author's XVth Chapter of his tract of Sal-Nitre, the arguments he hath against it, and his opinion to the contrary.

"His words therefore, as well as I can translate them, are these:

"Among the most celebrated bathes, we may justly reckon those of *Bathe*, in which admirable waters a continual vestal and sacred fire is maintained, as if things of a most different nature were interleagued. Before I come to the manner how these bathes receive their heat, it will not be improper if I make some inquiry into the contents of these waters.

"It is therefore manifest, that the bathes of Bathe are impregnated with a certain salt of an acrid nature; for if any sal alkali, or volatile salt purely salined, be mixed with these waters, a precipitation will ensue, and the waters will become turbid, and of a milky nature.

"Moreover, the Bathe waters powred on boyling milk, will coagulate it, as any other acid doth.

"Neither doth this acid salt seem to be the only salt of the Bathe, but is complicated with an alkali; for if the water be evaporated quite away, a certain salt of a more fixed nature will be found in the bottom of the vessel, which, on the powring of any acid on it, will ferment.

"Of the same nature also are the mud and sand of the bathe, which are wrought up with the springs; for any acid liquor being powred on them, an ebullition will follow.

"There may be also observed in these waters a salt, or rather a lime-chalk kind of earth, sticking to the bottom of the gouts, or passages, almost in all places where the water passeth.

From

" From what hath been said may be collected, That the bathes of Bathe are impregnated with a certain acid saline salt; and the salt of the bathe seems not much unlike tartar vitriolated, or aluminous salt. Early examination of the Bath waters.

" The reason why these salts destroy not one another, but each of them ferments with its contrary salt, may be understood from what hath been delivered in the former Chapter; to wit, these salts are so imperfect, that in conjunction they cannot destroy one another. But more of these salts hereafter.

" As to nitre and sulphur, with which the Bathes have hitherto been thought to participate, I suppose that neither of them is dissolved in those waters.

" That there is no nitre in the waters appears by this. That the salts that remain after the evaporation of the Bathe Water, put on a coal, burn not as nitre doth. Although I shall not deny, that those immature salts of an alkali nature (which are also contained in the sand and mud of the Bathe) being exposed some time to the air, may, perhaps, by its influence, be converted into nitre.

" As to sulphur, which hath been so much reported to be in all bathes, 'tis not, I believe, dissolved in these waters. Because,

" If a solution of alom, vitriol, or any other salt, whether acid, or fixt, be mixed with the water of the Bathe, sulphur discovers not itself to be precipitated, either by a fetid smell, or any other sign, which notwithstanding in the solution of sulphur in the water of unslack'd lime, or made into lixivium, doth appear, when the sulphur by the effusion of any acid liquor is precipitated.

" I am not ignorant that the water of these bathes, if salt of tartar, or a purely volatile salt, be cast into it, will presently turn white, as is declared before, which colour proceeds not from sulphur, but a stony, or aluminous matter precipitated, not much unlike to what is observed in the water of unslack'd lime, when any fixt salt is mixed therewith; in which, notwithstanding, it is not to be supposed the sulphur is dissolved; for if sulphur be boyled in water of unslack'd lime, the water becomes

 white,

Early examination of the Bath waters.

white, not by the effusion of a fixt salt, as before, but of an acid; so that the fixt salts may dissolve sulphur, but not precipitate it. Wherefore if sulphur be contained in the waters of the Bathe they would be precipitated, not by a purely saline, as formerly, but an acid salt, and the sulphur so precipitated would discover itself by a fetid smell, which it doth not do.

" To which I add, that an acid salt, or something aluminous, doth seem to predominate in the bathes aforesaid, so that they become altogether unfit to dissolve the sulphur.

" Moreover, if common sulphur be boyled in those waters they are never tinged with a yellow or sulphurous colour, neither can sulphur by any means be precipitated from the decoction, as I have often experimented.

" And therefore I must admire the famous Willis, in his Treatise of the Heat of the Blood, should affirm, that sulphur boyled in Bathe Water may be dissolved after the same manner, as if boyled in water of unslack'd lime.

" Now if sulphur seems to be dissolved in the waters aforesaid, the occasion of the mistake, I suppose to be, that the decoction was made in a vessel, in which some fixt salt had been decocted, so that the solution of the sulphur may be made by some particle of a fixt salt, with which the vessel might be seasoned.

" Concerning the bathes of Bathe, 'tis the common opinion that silver dipped into them is colored yellow, in the same manner as if it were cast into a solution of sulphur, and hence it is supposed that the Bathes have sulphur in them; but experience evinceth the contrary; for silver put into the Bathe Water becomes not reddish, or yellow, but rather black.

" The mistake may seem to arise from this, that 'tis customary with the Bathe-Guids to tinge and as it were guild over pieces of silver with the salino-sulphurous mud, or dung, such as is often found in houses of office, and put them off to strangers, for a little profit, as if they were coloured with the Bathe-water.

" And here this is to be noted, that a kind of bituminous mud, with a small pittance of common sulphur, is brought

brought up with the springs, which only swims on the top, or else continues at the bottom, but never is dissolved in the waters themselves.

Early examination of the Bath waters.

"Neither is sal armoniack, as some imagine, to be found in these waters, for if on the solution of sal armoniack, salt of tartar be injected, the purely saline volatile salt (of which sal armoniack in part doth consist) being at liberty from the acid salt, to which it was formerly united, will presently fly off into the air, and will quickly be discovered by a pungent affecting the nostrils, which is never observed in the Bathe-waters.

"Lastly, as to vitriol, the Crosse and Hot Bathe seem to have none at all; for if galls are beaten and infused into these waters they neither turn purple nor black, which would certainly be, if these waters had vitriol in them.

"The King's Bathe seems to have a little vitriol in it; for if some beaten galls are cast into that water, it will have a light tincture of a black purple colour.

"'Tis also to be noted, that a certain mineral of a metallick nature ariseth out of the earth, with springs of the Bathe, which is easily turn'd into vitriol. For if any acid liquor be affused on the sand, (which breaking out with the springs, is found in the bottom of the Bathe,) it being corroded with an acid menstruum, not without a remarkable effervescence, will in part be converted into vitriol, just as it happens to the filings of iron corroded with an acid liquor.

"For if that sand of the Bathe corroded with an acid liquor, be put into the infusion of galls, the liquor acquires an atro-purpureous colour. Whereas if the infusion of galls be put on the sand newly taken out of the bathe, and not corroded with an acid liquor, it will, by no means, be of a purple colour; an apparent sign, that the metallick sand of the Bathe, unless corroded with an acid menstruum, doth not turn to vitriol.

"It is further observable, that the sand of the bathe kept some time, and exposed to the open air, will of its own accord be converted into vitriol; for if that sand be mixed with the infusion of galls, the water will contract an atro-purpureous appearance.

"Moreover,

Early examination of the Bath waters.

"Moreover, if it be laid on the tongue, it hath a perfect vitriolick taste; and no wonder, for the nitro-aereous spirit, after some time, closeth with the metallick mineral, and salino-sulphureous marchasite, of which vitriol useth to be made, mixed in the sand, and causeth it to ferment, and at last, as was shewed before, converts it into vitriol."

Should the above extract prove interesting or amusing to your scientific readers, I shall be much gratified.

I am,
With much respect,
Sir,
Your most obedient servant,
W. R. CLANNY.

Durham, 15*th Nov.* 1806.

IX.

The Improvement of Boggy Land by Irrigation, as carried into Effect. By Mr. William Smith*.

Sir,

Improvement of boggy lands by irrigation.

HAVING paid very considerable attention to improvements of land by irrigation, and applied the water in a manner which I believe to be new and advantageous; I beg leave to submit my account thereof to the Society of Arts, &c. Upon this plan, the rushes and noxious parts are destroyed, the land is rendered firm, and grasses of good quality spring naturally. Even ferruginous waters will have a good effect thus used.

I am, Sir,
Your obedient servant,
William Smith.

Buckingham-Street,
Oct. 31, 1804.

To Charles Taylor, Esq.

* Soc. of Arts, Vol. XXIII. The silver medal was awarded for this communication.

Mode

Mode of improving Boggy Land.

The whole surface of the boggy ground was pared with a breast-plough, and the peaty matter thrown together in ridges, like common high-ploughed land, with a ridge, like a head-ridge, at one end of each set of ridges. Each ridge has a cut or channel for water on the top, and a drain in the furrow or hollow between it and the next ridge. The head-ridge has a larger channel for water on its top, which supplies all the other ridges with water, and this main ridge is itself supplied by its connexion with a larger channel or feeder, which first conveys the water out of the common brook-course into the meadow. Improvement of boggy lands, by irrigation.

The furrow between each head-ridge and the ends of the beds has a larger drain, into which all the channels of drains in the furrows discharge their water, and which is, by this main drain carried into the brook-course again. Thus the water is diverted out of its usual channel, only to float over the surface of the land, and run into that channel again lower down.

To get the water high enough to swim over the surface of any piece of ground, it is generally necessary to make a dam in the original channel, to pen up the water till it rises to the surface, or near it, and convey it along a channel which shall have less fall than the brook, until it can be got out upon the surface. The length of such conduit or drain must therefore depend upon the fall in the lands which lie parallel to the original channel of the water; and the quantity of land that can be covered with water, depends upon the distance between the proposed new channel and the old ones.

And, to perform this business in the most methodical manner, it is necessary to new model the surface, otherwise the water (which will always find its level) would lie too deep, or move too slowly over the low places in the ground, and thereby injure the grasses by a redundancy of water, while all the higher parts of the ground would appear like little islands above the surface of the water; and consequently receive no benefit from such an imperfect system of irrigation.

Where these inequalities of surface are large and numerous,

Improvement of boggy lands, by irrigation.

rous, it will be attended with much more expense to make such land marks into a regular form for floating, on account of the great expense of wheeling the earth from the hills to the hollows. In these cases, it is necessary (in order to avoid expense) to adopt an irregular method of floating: by taking advantage of such irregularities of surface, a meadow may often be floated at a quarter of the expense required to put it into a regular form, and this method is found to answer the purpose very well, if the works are properly laid out, with the spirit level. When the fall of water is ascertained, the form of the ground is the next thing to be attended to; if there are no natural declivities in the surface, down which the water may run from the overflowings of a cut on the summit into a drain in the hollows, so that the water may keep constantly running down such slopes by a regular current, which prevents a diminution on the ridges and a quick discharge in the lower drain; to avoid an accumulation in the furrows, it must be made with good slopes and plenty of drains; these, with a constant supply of water in the winter, are the most essential parts of a water meadow. The water must be constantly kept moving over the surface, and the practice proves, that where the water moves the quickest, there is always the most grass.

And, as the water must be constantly running off the land, it follows that it must be constantly running on, to keep every part of the surface properly supplied; and this requires a much greater quantity of water than is commonly imagined by those, who are wholly unacquainted with the practice of irrigation. In fact, every good water-meadow should be formed so that it may be said to be nothing but a wide extended channel for the water, no part of which should be too deep to prevent the points of the grass from appearing above its surface, consequently the water cannot be seen when the grass begins to grow. Yet it will still find its way between the shoots, and nourish the grass without bearing it down, or excluding it from the benefit of the air and sun: this is a state, in which the grasses of a water-meadow increase very rapidly; in this state, no water can be seen in any part

part of a meadow, but in the cuts which bring it on and drains that take it off; the motion down the slopes is only perceptible where it runs off the upper cut and in the lower drain; in the still more perfect parts, when the grass has got a considerable shoot, even this part of its motion is not perceptible; and a well-regulated meadow, in the spring, cannot be known to be in a state of irrigation without walking into it. The water running among its shoots, soon becomes perceptible to the foot which proves that there is no inconsiderable quantity running down the slopes, though its motion upon that part cannot be seen.

Improvement of boggy lands, by irrigation.

It is therefore one of the fundamental principles of irrigation, to keep the water moving, and that in such well regulated quantities as shall neither be too great nor too little; for both of the extremes are alike unfriendly to vegetation; but I believe there is much more mischief done to a water-meadow by giving it too little, than too much water, and the greater the supply the less nicety is required in the adjustment, if the meadow is so laid out as to prevent its accumulation in any part thereof. But where the quantity of water is small, it is necessary to be very nice in the distribution of it, in order to receive the full benefit of tbe stream upon as much land as it is capable of floating.

Here again we must not run into extremes, and try to get the water over too much land at a time, and thereby prevent the grass from receiving the full benefit of a quantity of water which is capable of giving it a good soaking: what that quantity is, will be best determined by practice, for some ground requires much more water than others.

In case of a short supply of water, which is extended to the improvement of as much land as it is capable of covering, according to the best principles of irrigation, it will be better to unite all the water upon such a portion of the work as practice shall prove it capable of covering well, and to let that part have the full benefit of the water as long at a time as is necessary to give a good soaking, or as long as it may be kept off the other parts without injury.

Improvement of boggy lands, by irrigation.

In some meadows, after they have had a complete soaking, which has saturated the soil, and the grass has thickened upon the surface, vegetation will not be retarded for some time for want of water, and those parts which were forced the most in the autumn, will require the least in the spring. It will therefore be always advisable on account of the water and a succession of grass, to get some part of the water-meadow as forward as possible in the autumn, that that part may be dried and fed the first in the spring, while all the water is employed in forcing on those other parts of the meadow which were neglected in the autumn.

By a prudent management of the water in uniting its vegetative powers upon those pieces of meadow which are disposed to produce the earliest vegetation in the spring, and so on in succession, from the earliest to the latest pieces of ground, or those which can be made so; a regular succession of grasses might be obtained, which would be much better than trying to get the whole alike, especially, if the quantity in one person's possession be very considerable, and his quantity of water likely to fail or barely to suffice for the purpose.

This method of using the water in succession upon portions of the meadow, which practice shall prove it capable of covering at one time, will be applicable to most meadows; for there are few, that are well formed, that have too much water, especially in the winter, or where there are any mills or navigations; I have generally observed that the best meadows upon the large streams, are those which have the most water and the best falls.

Account of the Nine Acres of Water Meadow, on Prisley Farm near Fletwick, Westoning, and Tingrith in Bedfordshire.*

As the quantity of water is sometimes insufficient to float the whole of this meadow at once, it has been contrived

* A map of this meadow, but without any account of the method of forming it, may be seen in the Communications of the Board of Agriculture, Vol. IV. page 341.

trived to be divided into three parts, by means of two large hatches within the meadow. Each of these principal divisions may again be divided into still smaller parts, by putting a common hatch or board made to the shape of either of the main feeders, which will stop the water out of any part, and force so much the more upon that which is intended to be floated. These contrivances are often necessary on account of the great scarcity of water, and also for the purpose of employing all the water upon any one part of the meadow, while the grass is feeding off the other; and (if the levels will admit of it) something like this ought to be done in every good water-meadow, for it is not merely the elevated or high-ridged form of the surface, which constitutes a good water-meadow, but such a disposition of the parts as is best calculated for the general purposes to which the land, the water, or its produce, may be most advantageously applied. The three parts of this meadow are upon two different levels, so that the drawing of either of the hatches before mentioned lays all the high part dry, and puts either the North or the South part of the lower level afloat at the same time. By keeping down one of those hatches and opening the other, all the water may be turned either upon the North or the South part of the low level, as occasion may require; or if both the hatches be shut down, the whole of the water may be used upon the high level, or two first sets of beds.

Improvement of boggy lands, by irrigation.

If there is more water than is sufficient to float either of the three parts separately, either of the two regulating hatches may be fixed at such a height as to use the remainder on the upper level; or the high level of the meadow may be made to receive its full quantity of water, and an opening be left under one or both of the hatches, so as to distribute the remainder of the water on either of the parts of the lower level, wherever it may be wanting; or the whole of the water may be used upon one of the lower levels, by adjusting the hatch so that that part shall have sufficient water, and drawing up the other high enough to discharge the surplus; or, if one part is floating, and neither of the other pieces in want of water, any overplus may be turned down the waste ditch which di-

Improvement of boggy lands, by irrigation.

vides the meadow from the upland, by drawing the outside or main hatch, high enough to discharge such surplus water under it.

The water is capable of all these variations, but there will seldom be any occasion for turning any water to waste, as it may generally be all employed upon the meadow or upon a third of it. If the other two parts should be in use, it will be found most advisable to feed only one part of such meadow at a time, as the other two-thirds might then be floating alternately.

When that third has been fed off, the most forward of the other two may then be laid dry for feeding, and the new-fed part floated in its stead. By this plan of feeding one-third at a time, and keeping the other two-thirds afloat at the same time, either together or separately, according to the quantity of water, the water will be always constantly employed from the first commencement of floating to the conclusion of the feeding and floating after it; when the whole may be shut up together for mowing.

The spring floating may be continued at intervals, (if the water be not foul) till the grass has gained a considerable height, but it must only be put on for a day or two at a time to cool the ground, and keep the grass growing. This management, if it be well conducted, will be of great service in forwarding the crop and increasing the bulk; the ground will also be the cooler and better for it when the crop comes off, consequently, it will occasion the after-grass to grow so much the quicker. No time should be lost in putting on the water immediately after the hay has been removed; or, as soon as one-third of the meadow can be cleared, the water should be immediately put upon that part till it is pretty well soaked, and then upon the other parts, in their turns, as soon as they are cleared. Great care should be taken both in feeding and taking off the hay, that it be done with a view of clearing that part first, where the water can be first applied to the purpose of producing another crop. The water should never run to waste but in the height of summer, when the grass may be high enough to form a thick cover to the ground, and keep it cool and moist enough

for

for the purposes of vegetation without the aid of water; and also at the end of summer or autumn, when, if the meadows are fed with sheep, there may be some danger of rotting them by using the water at this time of the year. It will appear to those who are acquainted with the management of Wiltshire water-meadows (by the account annexed, which I received from his Grace the Duke of Bedford, and which states the quantity of grass cut and the time of feeding the meadow), that the grass was begun to be fed off before it war fit; and, from the long time that the sheep were kept upon the ground during the months of February, March, and April, there was much of the water wasted, which should have hourly been employed at that most prolific season. Experience proves, that there is no danger of getting the grasses too strong upon the ground at this early season, and that crops which are six or seven inches high, and apparently too coarse and high for a bullock to feed, are eaten with the most eagerness by sheep in the spring; and those parts where the grass is the thickest and most luxuriant, are always fed the closest, and sought after with the greatest avidity. This being contrary to the common habits of all animals which graze upon dry pastures, where they give a decided preference to short and sweet herbage, may lead many persons to think that the grass of a water meadow may be too high and luxuriant for sheep; but experience has proved, that such long grass is neither unfriendly nor unsavoury to them; and we know, that the grass always grows the fastest when it has gained considerable height and strength. It will also thicken at the bottom, and the roots will get much stronger hold in the ground, and consequently will not be subject to feel the want of water so soon during the time of feeding, and be able to make a much stronger shoot as soon as it is shut up again, and the water restored to it. The greatest crop will also be of the best quality both in grass and hay, and will always be fed much closer and evener than in those places where the floating has been any ways deficient. The drowner, as he is generally called, or the man who has the superintendance of water-meadows, should therefore endeavour to make every part of the crop as uniform as possible;

Improvement of boggy lands, by irrigation.

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possible; for no meadow can be said to be complete till that is accomplished, and a good eye may easily discover the management of a meadow by the crop upon the ground, whether it be in the spring, summer, or autumn: for, if the grass appear patchy, or of different sorts and colours, there can be no doubt but that the water has been partially applied. The different shades of the ground after close feeding and mowing, will also show the parts which have had the most water, and where it has been deficient.

Workmen who have been accustomed to the mowing such crops, can also tell all those parts by the different cut of the grass. Much of the perfection of a water-meadow also depends upon the care and pride which the drowner takes in doing his work well. It would therefore be very advisable not to change those men too often, but to keep the water-meadow constantly under the care of the same workman, so long as he manages it well; and no one should ever alter the water but him who has the constant care of attending it. Water-meadows will never be brought to perfection in any country, till the proprietors and managers of them shall take a pride in doing them well, and strive to rival each other in excellence. Land-owners and agricultural societies should therefore offer premiums for the greatest produce that can be obtained from a given quantity of water-meadow, and a smaller premium to the drowner or managing man. This would excite emulation, and create a conversation and rival spirit of industry, and attention to a pursuit which many might not otherwise have thought about; as the crops of water-meadows are much more at the command of the farmer, and less subject to blight, drought, or uncertainty of season, than any other crop which he cultivates; this would be a fair subject of competition in the skill of the managers, and the premium should not be determined by the produce of a single crop, but by the aggregate produce of the whole year, taken in spring-feed, hay, and autumn-feed.

Account

Account delivered to Mr. Smith, by order of his Grace the Duke of Bedford, of the produce of nine acres from Prisley Water-Meadow, made out of a Bog. Improvement of boggy lands, by irrigation.

1803. March 29.—Stocked it with 12 score of sheep, kept them three weeks.

April 16.—Shut it up for hay.

June 23.—Cut the first crop of hay, supposed to be above two tons per acre.

August 20.—Cut the second crop, supposed to be one and a half ton per acre.

September 16.—Stocked it with four score of fat sheep, three weeks; after that it was pastured with lean bullocks, as long and as often as they could find food.

1804. February 27.—Stocked it with eight score and four lamb-hogs.

April 28.—They have now been nine weeks. This is more than eighteen sheep to an acre for nine weeks. It had more and better water this last winter than the winter before, but from our want of grass upon the farm, we have eaten it longer than we should have done.

June 21st.—Began cutting the first crop of hay, which is a greater quantity than the year before, and a larger proportion of the best grasses.

N.B. At the Woburn sheep-shearing in June, 1805, the above meadow was examined by the Secretary of the Society, when the quantity of the grass upon it was not only found to be great, but the kinds of grass it produced in general, excellent in quality, and appearing, on comparison, to improve every year.

Reference to the annexed Plan of the six Acres of Water-Meadow, on Prisley Farm.—Plate VIII.

1. The main hatch, which, when closed, occasions the water that is to irrigate the meadow, to flow into the feeder which fills the highest cuts, made upon the first eight

Improvement of boggy lands, by irrigation.

eight ridges, from which cuts it gently glides down the slopes into the eight drains, which unite and discharge themselves under the arch at b.

2. The second hatch, which regulates the water for the ten ridges in the second division of the meadow.

3. The third hatch, which regulates the water for the five ridges in the third or lowest division of the meadow, from whence it falls into the old course of the brook*.

X.

On the Use and Abuse of Popular Sports and Exercises, resembling those of the Greeks and Romans, as a National Object. By SAMUEL ARGENT BARDSLEY, *M.D. From the Memoirs of the Manchester Society, Vol. I.*

(Concluded from p. 222.)

Bull-baiting condemned

ALTHOUGH persons of rank and education, at the present period, have abandoned bear and bull baiting to the lowest and most despicable part of the populace; and even among them these sports are much less frequent than formerly; yet the practice meets with countenance in some parts of the kingdom, and has been supported not long since, in one of the first assemblies of this nation, extolled by men of rank and abilities, as encouraging harmless amusement, manly spirit, and contempt of danger.

These opinions appear to be so much at variance with the present enlightened, liberal, and humane state of society, that to hear they have been defended by serious arguments and with persevering ardor, is sufficient to excite both regret and astonishment. Cruelty in every shape is unjustifiable; but wanton deliberate barbarity is dishonourable to our nature, and contrary to the principles of natural religion, honour, justice, and humanity.

* A certificate, in terms of high approbation, was given by Mr. Farey, of Crown Street, Westminster.

Of

Of all the cruel sports, bull-baiting, as generally practised, is, perhaps, the least defensible. It is not only a cruel, but a foolish and detestable diversion. That the spectacle of two animals endowed with courage, strength and activity, exerting their antipathies to each others destruction, upon fair and equal terms, should excite our curiosity and animate our feelings, is reconcileable to the constitution and nature of man; but that any human being should delight in beholding a noble and useful animal tied to a stake, and deprived in a great measure of the means of offence and defence, and then worried and tormented by dogs and men, is a sport so insipid, so unsportsman-like*, and so cruel, as to excite wonder as well as detestation. But the advocates of these and similar cruel diversions, exclaim in a tone of triumphant interrogation——"Do not these sports inspire manly courage and contempt of danger?"—Certainly not. They are only calculated to generate cruelty and a thirst for blood. They may, indeed, inspire ferocity and insensibility to danger, but they are unfit to impart genuine and manly fortitude.

— on account of baseness and cruelty.

The Romans indulged, as before remarked, in these savage diversions to a greater extent than any other nation of antiquity; yet they did not excel the Greeks, nor

The Romans did not derive courage from these cruel sports.

Cock-fighting.

* Throwing at cocks is another specimen of unmeaning brutality confined solely to our own country. After being familiarized to the barbarous destruction of this courageous bird in the cock-pit, it was only advancing one step further in the progress of cruelty, to fasten this most gallant animal to a stake, in order to murder him piece-meal. This detestable barbarity has declined as our manners have become more polished and humane; but the strong hand of the law was obliged to interfere in many places to hasten its abolition. The cruel treatment of the animal race might well lead an ingenious foreigner† to remark, when describing our popular diversion, as follows: "The women of Rome beheld barbarities and murders in cold blood; but the boxing-matches—the bull-baitings, cock-fightings, and the numerous attendance of both sexes at public executions, indicate that there is at least a remnant of Roman manners, and the taste of those times, left in England"

† Wenderborn, on the character and manners of the people of Great Britain.

have surpassed the moderns, in the display of military ardour and true courage.

It is a superficial and unphilosophical view of the subject, to consider the barbarous sports of Rome contributing to the establishment of her power and military fame. These spectacles never became common till after Hannibal's defeat; and that the Romans, subsequent to this period improved in valour and hardihood, is not recorded in the pages of their history. But may we not, with just pride, appeal to facts furnished by our own age and country? Has the valour, enterprize, or intrepidity of British soldiers and sailors shone less conspicuous, since the period that bull-baiting and other barbarous sports have declined, throughout most parts of the kingdom? The answer is recorded in the history of our late naval and military transactions.

Nor are Spain and Portugal exalted for their bull-fights.

The conduct of the Spaniards and Portugueze, when contrasted with that of our own countrymen, is a striking proof of the incompetency of savage and cruel amusements to create a courageous and warlike disposition. Bull-fights still constitute the only active popular amusement of the two countries. If these bloody sports were capable of inspiring active courage and manly fortitude, how are we to account for the acknowledged degeneracy of the people of Spain and Portugal in these warlike qualities?

Arguments with regard to Britain, and the influence of its sports.

The advocates for bull-baiting and similar sports, have recourse to another argument, or rather assertion, which they urge with great confidence: "Cruel sports," they contend, "do not necessarily generate cruelty in a people." "The English, (say they) who are fond of these diversions, are, at the same time, less ferocious, and indeed hold the shedding of human blood more in abhorrence than any other nation on the face of the globe." Granted that we really deserve this honourable distinction—Does it follow that human nature is differently constituted in England to what it is in other parts of the world? Can it be necessary to prove, that habits of indifference to human suffering are acquired by repeated acts of cruelty to brutes; and that the sympathy of our natures must be blunted in proportion to our familiarity

with

with scenes of unnecessary and wanton barbarity? These are almost self-evident suppositions; at least they are such inductions from daily and repeated experience, as to pass current for intuitive truths. But if we admit that the English are more addicted to cruel sports, and yet hold human life more sacred than the people of other countries, it by no means follows, that such sports have not a tendency to create a disposition to cruelty. How then are we to reconcile this apparent contradiction? The paradox, if there really be any, is not difficult of solution.

Arguments with regard to Britain, and the influence of its sports.

The life of man is always most respected, where it is of most consequence. For, in a country like Britain, where the whole body of the people enjoy political and civil rights, their own importance, and that of their fellow-citizens will be felt and esteemed; and where just and equal laws protect the life and property of the meanest of the people, and consequently private injuries can be redressed by an appeal to the tribunals of justice, man will be less disposed to be the avenger of his own wrongs. Besides, ignorance is commonly the parent of cruelty. Now it may be safely asserted, that the knowledge of man's duties both towards his neighbour and his Creator, are better understood and more widely diffused amongst the mass of the people in this kingdom, than in those otherwise civilized countries, where a thirst for the blood of their fellow-creatures seems chiefly to prevail. These eminent moral and political advantages are the powerful counteracting causes of that spirit of barbarism which cruel diversions are calculated to excite. If it be desirable then to efface the harsh lineaments of rudeness, and a want of feeling nearly allied to brutality, which still mar the otherwise fair visage of the national character, let all barbarous diversions be entirely abolished; but especially let the sport of bull-baiting be the first offering to be sacrificed at the shrines of humanity and justice! "A diversion," to speak of it in the language of a justly celebrated orator *, "which may be charac-

* Sheridan. Parliamentary Debates on the abolition of Bull-baiting, &c.

terised as inhuman, cruel, disgraceful, and beastly, and which can excite nothing but brutality, ferociousness and cowardice; for, its direct tendency is to debase the mind, deaden the feelings, and extiuguish every spark of benevolence."

II. The amusements which depend on bodily exercises and personal contests.

On the art of boxing.

It is not compatible with the limits of this essay to notice the variety of bodily exercises and active sports to which the people of England are generally addicted. But there is one kind of personal contest, to the consideration of which the remaining part of these remarks will be chiefly devoted, as it has been the source of obloquy and reprobation among foreigners, to the national character. The public exhibition of boxing, and the practice of the same art in deciding private and personal quarrels, are here alluded to.

Whether pugilism be commendable

The exhibition of pugilism on a public stage, is most probably a relic of one species of the Roman gymnastic. This mode of venal stage-fighting is a barbarous prostitution of a manly and useful art, whether considered as an exercise calculated to inspire fortitude and intrepidity, or to afford efficacious means of defence against personal insult and violence. But when considered merely in the light of yielding gratification as a public spectacle, or of furnishing an opportunity for gambling speculations, it is then viewed in all its naked deformity—Yet, is not the art of boxing, by which instantaneous insult may be avenged, or personal injury averted, less dangerous than any other practice adopted by the inhabitants of the continent on similar occasions and for similar purposes? The question is an important one; and the following facts and observations may serve, perhaps, to apologize for, if they cannot justify, a custom so interwoven with our national manners and character.

It is less dangerous than most other means of sudden combat.

If man cannot be prevented from some appeal to violence, then—

So long as man is subject to the imperfection of his nature, he must be compelled to acquire the art of self-defence, as well as that of annoyance to others. Our experience of his conduct and character, teaches us the impossibility of extinguishing the passions of pride and resentment, which, although they frequently involve him

in

in misery, are still the sources of some of his noblest qualities and attributes. As some portion of evil will attach to the best and wisest system of moral or civil restraint; that policy is, perhaps, the wisest, which legislates for man as he is, not altogether as he ought to be. Suffer the passions to reign uncontrouled, and you dissolve the bonds of society; stifle the active energies of a resolute independent spirit, and you degrade the man into a passive slave. The feeling of resentment for unprovoked injury and insult is a salutary, if not instinctive provision of our common nature. It may be asked—"Is man then to be the judge and avenger of his own wrongs? Is not every offence against the person of a citizen a breach of the laws of society? and should it not be punished as such?"——Certainly:—But if in the best regulated states it be found impracticable to prevent man from frequently asserting a claim to the vindication of his own real or supposed wrongs, it then becomes a question of *expediency* as to the most preferable mode by which he may be enabled to obtain this end. Boxing may not unjustly be considered as the most eligible means of offence and defence. It is properly ranked among those athletic exercises, which, at the same time that they impart address and strength to the body, inspire courage and fortitude in the mind. It may indeed lead *bad* hearts and *bad* heads into acts of presumption and petty tyranny; but this propensity to an improper exertion of skill and courage would be checked, in proportion as men were more *equally* possessed of the means of defence or aggression. They would learn to respect the skill and bravery of each other, and consequently be less prone to undue resentment and quarrels. The government that would attempt, with a despotic and severe authority, to controul the exertions of self-confidence, and a moderate exercise of just resentment, could only expect to rule over a nation of timid and revengeful slaves. The open and ingenuous expression of manly indignation might be repressed; but the rancorous feelings of malignant revenge would be fostered and encouraged. But no state can, with any prospect of success, attempt such an absolute dominion over the passions of men. And if it did, "it

— boxing is most eligible, for various reasons.

"it must (according to the observation of a spirited author) in order to act consistently, prohibit the use of knives, hatchets, and even pokers; for any of these, upon a sudden emergency, might impart a fearful power to the enraged and the feeble."

Other countries use more destructive means.

If we consider the practice of other countries, where boxing is unknown, we shall find, that the modes of resenting injuries, resorted to by the common people, are full of danger and ferocity. In Italy *, the stiletto is not only the weapon of the hired assassin, but is also kept ready in the bosom of the respectable citizen, to be plunged into the heart of his friend or neighbour, upon any sudden provocation from anger, or motive of revenge.

Destructive effects of want of regulation in personal struggles.

When the passions are under greater restraint, from the influence of laws, of climate and of custom, such dreadful consequences do not ensue from the quarrels of the populace †. Yet even in France, and most parts of Germany, the quarrels of the people are determined by a brutal appeal to force, directed in any manner, however perilous, to the annoyance or destruction of an adversary. Sticks, stones, and every dangerous kind of weapon, are resorted to for the gratification of passion or revenge. But the most common and savage method of settling quarrels upon the continent is the adoption of the Pancratium. The parties close, and struggle to throw each other down; at the same time the teeth and nails are not

* In an authentic publication of the life of the late Pope, it is affirmed, that upwards of 1000 persons annually fall victims in Rome to the stiletto; either by the hands of the hired assassin, or in private quarrels. Dr. Moore reckons the number of murders in Naples, by the dagger, at not less than 400 annually.

† The mode of fighting in Holland, among the seamen and others, is well known by the appellation of Snicker-Snee. In this contest sharp knives are used; and the parties frequently maim, and sometimes, destroy each other. The government deems it necessary to tolerate this savage practice. Certain fines are imposed if wounds be inflicted on dangerous parts of the body; but a very trifling, and indeed seldom any punishment ensues, provided the general rules of the combat have been adhered to.

unemployed.

unemployed. In short, they tear* each other like wild beasts, and never desist from the conflict till their strength is completely exhausted; and thus regardless of any established laws of honour which teach forbearance to a prostrate foe, their cruelty is only terminated by their inability to inflict more mischief. And yet superficial observers, and especially all foreigners who have written concerning our customs and manners, loudly brand the English character with savage rudeness and brutality, because they have seen men terminate their quarrels by an appeal to boxing; in which the parties are not permitted to take an unfair advantage of each other, but when one is disposed to yield, the combat immediately closes, and the conqueror and the vanquished are often seen to give and receive a hearty shake of the hand, in token of mutual good will and forgiveness. In no instance does the manly, spirited, and generous character of Britons, rise to a higher pitch, than in this alacrity almost universally shewn by the most ignorant and lowest order of the people, to terminate their personal contests in a kindly and honourable manner. The mind indeed is thus relieved at once from the brooding mischief of malice and revenge. For, when the idea of self-consequence has been maintained, in courageously supporting the contest, man is better satisfied with himself and others, and consequently more likely to dismiss his ill-will and resentments. In order to foster manly fortitude and vigour, and to prevent the mischiefs arising from the irregular and brutal exertions of strength and ferocity—would it not be advisable to encourage the art of boxing with mufflers, as a subordinate branch of the gymnastic exercises? All *stage* exhibitions of *prize-fighting* ought

In boxing no unfair advantage is ever allowed.

* In Virginia and the other southern states of America, the most savage acts of barbarity are committed, in the quarrels of the people. Gouching—or thrusting out the eye from the socket, is one of the means resorted to upon almost every personal dispute. An intelligent traveller, Mr. Weld, declares, that at Richmond in Virginia, it was nothing uncommon to meet with persons deprived of one or both eyes from this horrid practice. He mentions another mode to disable an antagonist, so detestably barbarous, as to excite incredulity, if the account had not been corroborated by other writers.

to

to be rigidly prohibited; nor should men ever be suffered to prostitute their strength and valour for the sordid purpose of gain.

Where boxing is not used in our country, there is a greater use of barbarous sports.

It is a singular though striking fact, that in those parts of the kingdom where the generous and manly system of pugilism is least practised, and where, for the most part, all personal disputes are decided by the exertion of savage strength and ferocity—a fondness for barbarous and bloody sports is found to prevail. In some parts of Lancashire *bull-baiting* and *man-slaying* are common practices. The knowledge of pugilism as an art is, in these places, neither understood nor practised. There is no established rule of honour to save the weak from the strong, but every man's life is at the mercy of his successful antagonist. The object of each combatant in these disgraceful contests, is, to throw each other prostrate on the ground, and then with hands and feet, teeth and nails, to inflict, at random, every possible degree of injury and torment*. This is not an exaggerated statement of the barbarism still prevailing in many parts of this kingdom. The county assizes for Lancashire afford too many convincing proofs of the increasing mischiefs arising from these savage and disgraceful combats.

Murders prevail more in the Northern Circuit, where they do not box.

The Judges, on these occasions, have frequently declared in the most solemn and impressive charges to the

* A disgusting instance of this ferocious mode of deciding quarrels, was not long since brought forward at the Manchester sessions. It appeared in evidence, that two persons, upon some trifling dispute, at a public-house, agreed to lock themselves up in a room with the landlord and " fight it out" according to the Bolton method. This contest lasted a long time, and was only terminated by the loss of the greatest part of the nose and a part of an ear, belonging to one of the parties, which were actually bitten off by the other, during the fight. The sufferer exhibited at the trial, part of the ear so torn off; and when asked by the counsel, what had become of that part of his nose which was missing—he replied, with perfect naiveté—" That he believed his antagonist had swallowed it!!" It has happened to the writer of these remarks to witness, in more than one instance, the picking up in the streets, lacerated portions of ears and fingers, after these detestable and savage broils. Surely either our laws or manners might interfere in suppressing such deeds of savage barbarity!

Grand

Grand Jury, that the number of persons indicted for murder, or manslaughter, in consequence of the bestial mode of fighting practised in this county, far exceeded that of the whole Northern* circuit; and that, in future, they were determined to punish with the utmost rigour of the law, offenders of this description—But, alas! these just denunciations have little availed. Is it not then highly probable, that the evil which the severity of the law has been unable to correct, might be gradually and effectually abolished, or at least greatly mitigated, by the encouragement of a more manly, and less dangerous mode of terminating the quarrels of the populace? In the Southern parts of this kingdom very rarely (and then chiefly in pitched battles for gain) is there any danger to life or limb from the practice of fair boxing. If then in the public schools and large manufactories of Lancashire, where immense numbers of boys are under the entire controul of their masters and employers, some pains were taken to introduce the manly system of boxing, and the laws of honour, by which it is regulated, there can scarcely be room to doubt, but that the life of man would be more respected—barbarous propensities subdued, and the present character of the county rescued from the stigma of savage rudeness. It has been asserted, by those qualified to judge, that since the late diffusion of the knowledge of the pugilistic art by itinerant practitioners among the Northern inhabitants of this kingdom, the mere exertions of brutal strength and ferocity have somewhat fallen into disuse, both as exercises of pastime, as well as means of offence and defence. In order therefore to abolish all traces of the savage mode of contest which has been so fully described, would it not be adviseable to hold forth prizes, at wakes and public amusements, (where the populace assemble chiefly for the purpose of diversion and pastime) for the encouragement of those, who excelled in sparring with mufflers? This trial of skill, force, and agility (which was at first the practice of the antients) would contribute, *under due regulations*, to

It would be adviseable to introduce boxing into the manufacturing towns, &c.

* At one assizes, no less than nine persons were convicted of manslaughter, originating from these disgraceful encounters.

invigorate the body and animate the courage; and effectually abolish the present dangerous and inhuman method of deciding personal contests.

XI.

Extract from a Memoir of Vauquelin, read to the French National Institute, on the Chemical Properties of Oisanite, compared with those of Titanium, and shewing that the former is the first species of the latter.*

Suspicion of analogy between oisanite and titanium.

SEVERAL years ago, M. Vauquelin indicated an analogy between oisanite and titanium; but as his opportunities at that time permitted him to make experiments upon small quantities only of the oisanite, and the crystalline form seemed inimical to his conjecture, an uncertainty remained which rendered him desirous of repeating his analysis upon a larger scale. It was not till the present year, that by making an excursion into Oisan, he was able to procure a sufficient quantity of that substance for his purpose.

Suspecting that the difference of form and specific gravity between titanium and oisanite might depend on the state of oxidation, he heated equal quantities by the same fire; but no change was produced in either substance. He simply remarked that the titanium became more decidedly red, which was owing to a small quantity of iron contained in it.

They have the same habitudes with alkalies.

Titanium and oisanite comport themselves in the same manner with the alkalies; they combine with them by the assistance of heat, swell up, become white, and are even in part dissolved when water is added to the combination.

It cannot be doubted but that these substances really combine together, because it is impossible to separate them by water or by any other mechanical means. In this state of combination with alkali, the two substances are

* Journal des Mines, No. 114, June, 1806.

soluble

soluble in acids and form triple salts which are easily decomposed by moderate heat.

After having dissolved titanium and oisanite separately in muriatic acid, he subjected them to the action of various re-agents. He remarked that both were precipitated of a fine blood red, by the infusion of nut galls; but that the solution of oisanite afforded a yellowish brown precipitate with prussiate of potash, while the solution of titanium formed a very deep green precipitate with the same re-agent. The author suspected that this last colour might arise from a portion of iron contained in the titanium; he mixed a few drops of muriate of iron with the solution of oisanite, and he then obtained a green colour entirely similar to that which the titanium had exhibited. After having evaporated the solution of titanium to dryness, he washed the residue with distilled water, and obtained a yellow liquid, leaving behind a white substance insoluble in water and the acids; but this matter being again fused with potash and washed to carry off the excess of alkali, was easily dissolved in acids.

The muriatic solutions afford a red precipitate by galls, but the precipitates with prussiate differ owing to iron in the titanium.

The liquor arising from the solution of titanium evaporated to dryness, precipitated a blueish green with prussiate of potash; the solution of the residue being again fused with potash, was, on the contrary, precipitated of a yellowish brown, like that of oisanite, by the same agent and not green as before.

They do not differ when purified.

By this operation, M. Vauquelin having separated the iron from titanium, the solution of the latter then presented absolutely the same properties as those of oisanite. Hence he concludes that the only difference between oisanite and titanium consists in a small quantity of iron and of manganese contained in the latter; but he doubts whether these substances be the cause of the form which distinguishes the oisanite; for these impurities are very small in quantity and may be for the most part separated by muriatic acid.

Oisanite is therefore the first species of the genus titanium.

From these experiments of Vauquelin, it is necessary that oisanite should be removed from the class of stones and placed in that of the metals, under the genus titanium, of which it ought to constitute the first species.

The editors of the Journal des Mines remark in a note that M. Hauy had already conjectured, as was announced in their 61st number, that oisanite, which he denominates anatase, must include a metallic substance. His observations on the form and several other characters of that mineral prove that it constitutes a particular species, which must be separated from the oxides of titanium and placed in the genus of the metal itself.

SCIENTIFIC NEWS.

A Report of the Transactions of the Class of Mathematical and Physical Sciences of the National Institute of France for the preceding Year, was made at the public Meeting of the 7th of July last, of which the following is an Abridgement.

Topography of Persia, extreme dryness and sterility of the soil, &c.

M. OLIVIER presented an account of the "Topography of Persia." He has described the chains of mountains, the courses of the streams, and the productions peculiar to the climate. The nearly absolute drought which prevails, is the cause why not more than one twentieth part of this vast empire is cultivated. Entire provinces have not a single tree which is not planted and watered by the hands of men. This evil constantly increases by the dilapidation of the canals by which the water from the mountains was formerly conducted to the lands, and the territory becoming impregnated with salt, becomes eternally barren.

Conjectures of Lacepede respecting seas and lakes in the interior of Africa.

The reflections of the studious and sedentary cultivator of natural history, may lead to results well calculated to divert the pursuits of travellers. M. de Lacepede, by examining what is at present known of Africa, by comparing the volume of the rivers which arrive at the sea, with the extent of the regions upon which the rains of the torrid zone fall, and the quantity of evaporation to be observed, and lastly, assisting his judgment by the number and direction of the chains of inland mountains, as described by travellers, has offered some conjectures respecting the physical disposition of the countries

countries still unknown in the centre of that quarter of the globe, and more particularly the seas and great lakes which he thinks must there exist. He has indicated the courses which appear to him to be proper for most speedily exploring those countries which still remain to be discovered.

There is another description of conjectural geography, which seems to determine the antient state of places, from what is at present to be seen. M. Olivier has in this manner examined how far it may be admitted that a communication formerly existed between the Caspian and the Black Sea. He thinks it existed to the north of Caucasus, and that the alluvions of the Couban, the Wolga, and the Don have interrupted it. Diminution of the Caspian Sea. Its antient state.

Since that time, the Caspian not receiving from the rivers which fall into it a sufficient quantity of water to supply its evaporation, has continually sunk in its level, and is at present sixty feet lower than the Euxine Sea. In this manner it is that it has been separated from the sea of Aral, and has left uncovered the immense plains of salt sand which surround it to the north and to the east.

M. Dereau de la Malle, son of one of the members of the Institute, has found numerous testimonies in the Greek and Roman authors of this ancient extent of the Caspian Sea, and his communications with the Euxine and the Aral. He has presented a long memoir on the subject to the Class, and to that of Ancient History and Literature. These researches afford an additional proof of the utility of connecting the exact sciences, with researches of erudition.

M. Monges has given some observations on two antient mill stones, dug up near Abbeville, from which, as well as from examination into the writings of the antients, he determines, that they made their mill stones in general of porous basaltes. Ancient mill stones.

M. Desmarets, from an examination of some antient garments, found in a tomb of the Abbey of St. Germain, has determined that most of the processes of weaving, at present used, were known in the 10th century, and he has thrown new light upon the articles of Pliny respecting the antient fabrics. Piece goods formed by the loom in antient times.

Several

Botanical works.

Several important botanical works have appeared. The Flora of New Holland, by M. de la Billardiere; the magnificent description of the Garden of Malmaison, by Ventenat, have arrived at their nineteenth livraison. The Flora of Ovare and of Benin, by M. De Beauvois is at its fifth. A fifth volume of the Botaniste Cultivateur of Dumont Courset has appeared, and M. La Marck has given in conjunction with M. Decandolle, a third edition, greatly enlarged, of his Flora Françaíse.

M. de Beauvois has begun to publish the insects which he collected on the African and American Coasts. Two parts have appeared.

Cuvier on animals without vertebræ.

M. Cuvier has continued the two great series of researches which he has been engaged upon several years, upon animals without vertebræ, and upon the fossil bones of quadrupeds. In the first of these series he has this year given the anatomy of seven genera; the Scylla, the Glaucus, the Eolides, the Colymacon, the Limax, the Limnæ, and the Planorbe. The two first are very little known, even externally, and the author has rectified the false notions of naturalists with regard to them.

In the second series he treats of the fossil bones of bears, rhinoceros, and elephants.

And on the fossil bones of animals.

Two species of bears, at present unknown are buried with tygers, hyenas, and other carnivarous animals in a great number of caverns in the mountains of Hungary and Germany.

Fossil bones of the rhinoceros and elephant.

Bones of the rhinoceros are found in abundance in the uncompact grounds in all parts of the globe, where excavations have been made. The author has collected notices of more than six hundred places of the two continents, where the bones of elephants have been dug up, and very recently the grinders and tusks have been found in the forest of Bondy, in digging the canal which is intended to bring the waters of the river Ourque to Paris. The more we advance to the north, the better is the state of preservation of these bones. An island of the Icy Ocean is almost entirely formed of them.

—belong to extinct species.

These facts were in great part known; but it follows from the detailed comparison made by Cuvier, of the bones of the rhinoceros and elephants at present living in Africa and

and the Indies, with those of the fossil animals, that they are respectively of different species.

—having peculiar characters.

The fossil rhinoceros had shorter legs, a larger head, of greater length, the snout being very differently formed from that of the present rhinoceros. The elephants had the grinders, the head, and particularly the alveoli of the tusks very differently constructed, and the trunk had other proportions.

—which formerly lived where their bones are now found.

The author concludes therefore that these two species are extinct, as well as so many others of which he has discovered the bones and ascertained the characters, and of which ten or twelve hitherto unknown to all naturalists, have their bones incrusted in the plaster stones of the neighbourhood of Paris.

He also thinks that these species have lived in the places where their bones are found, and that they have not been brought thither as has been generally thought, by an inundation, for their bones are not worn by friction.

Chemical news

The chemical transactions of the preceding twelvemonth which bear relation to the Institute, are mentioned in this report. The new edition of Fourcroy's Philosophy of Chemistry, The Experiments of Count Rumford on the Communication of Heat through Water, and on the adherence of the particles of that fluid together, both which have appeared in our Journal, are stated by the reporter. He also gives a short analysis of the Labours of Berthollet on Chemical Statics, which that able chemist still continues to pursue. M. Berthollet, while he shews that very large quantities of carbonic acid, may, by pressure, be united with the alkalis and earths, takes notice at the same time that these combinations are complete throughout, and not that, as is commonly imagined, one of the principles is superabundant, and as it were disengaged while in excess beyond saturation. In proof of this he remarks that the smallest drop of sulphuric acid, added to a sub-carbonate, does not seize upon a portion of free alkali, but immediately decomposes a portion of the whole salt, and disengages the carbonic acid. And so likewise he remarks that the acidulous sulphate of soda effloresces in the air, which it could not do if any portion of sulphu-

Researches on the chemical affinities, by Berthollet.

ric

ric acid were uncombined; for there is no substance in nature which is more strongly attractive of water.

Measure of the degrees of acidity in different acids compared together.

M. Berthollet has established a method for ascertaining the degree of acidity of the acids, and of the alcalinity of the different bases, by the quantity required of each to saturate or completely neutralize the other, so as to give no sign of either acid or alkaline qualities.

He confirms this method by shewing that the proportions of these quantities are constant, and that if, for example, it be necessary to add to any base twice as much of any species of acid to saturate it as to saturate another base, the former of these two bases will require twice as much of any other species of acid for its saturation as the second will require.

Combinations disunited by heat more readily when water is present.

But the degree of resistance to heat does not correspond with this force, and it is more easy for example, to decompose the carbonate of magnesia than that of lime, by fire, though the affinity of these two earths for the acid is nearly the same. This difference arises from the much greater quantity of water in the first carbonate; and other experiments shew that water favours the disengagement of carbonic acid.

Extensive consequences of this doctrine.

The consequences of these facts, with regard to all the branches of chemistry, particularly the theory of analysis are very important. The tables of affinities and great part of the analyses hitherto made are shaken, and experiment proves in fact that most of these results demand further revision. For example, Klaproth, and after him Vauquelin have found one fifth of fluoric acid in the topaz where it was never suspected. This stone must therefore be ranged among acidiferous substances. Another mineral hitherto considered as a stone, namely the oisanite, must be ranged among the metals; (for which see our present number) and various other instances no less striking and important, are given by the reporter.

History of the late discoveries on platina.

M. Fourcroy has given an account of his experiments on platina, with an history of what has been done by others. Of this last, in abridgement, I give the substance without undertaking to examine into the facts and dates myself.

Descotils attempting to discover the cause of the different

ent colours of the triple salts of platina found that the red colour of some of them was owing to an unknown metal. Fourcroy and Vauquelin, by examining the black powder which remains after dissolving platina, and finding that in some experiments, a metallic vapour having a strong smell was elevated, and that in others, the substance was exhibited in a more fixed manner, considered this powder as a new metallic substance, of which they attributed the different properties to different degrees of oxygenation.

But during this time, Mr. Tennant examined the same black powder at London, and succeeded in decomposing it into two different metals, the one fixed, and the other very volatile; and Dr. Wollaston, another English chemist, by examining the solution which was till then supposed to contain only platina, had also discovered two other metals, different from platina and from those which form the black powder.

So that after the long and painful researches of which this singular metal has been the object for upwards of forty years, chemistry has succeeded in developing eleven metallic substances in its ore; namely, platina, gold, silver, iron, chromium, and titanium discovered by Messrs. Fourcroy and Vauquelin in the more or less coloured sands which are always mixed with it, the two new metals of Wollaston, Palladium and Rhodium, and the other two of Tennant, namely, iridium and osmium.

Short descriptions of these are given, which I shall also transcribe.

Palladium is white, ductile, heavier than silver, very fusible with sulphur, soluble in nitric acid, forming a red solution, precipitable in the metallic state by sulphate of iron, and of a dirty green by prussiate of potash; and forming with soda a triple salt, soluble in alcohol. It was for a short time considered as an alloy of platina and mercury. Description of Palladium.

Rhodium is grey, easily reducible, fixed and infusible, colouring its acid solutions of a rose red, which muriate of tin renders very intense; precipitable of a yellow colour, by the alkalis, and not at all by prussiate of potash. Its triple salt with soda is insoluble in alcohol. —of rhodium.

— of iridium. Iridium is white, very hard, difficult to fuse, nearly insoluble in nitro-muriatic acid, and not at all in any other; oxidable and soluble by the fixed alkalis; and its oxide is soluble in acids, giving varied and lively colours to its different solutions. These are the red salts which colour those of platina.

— of osmium. Osmium is a metal not hitherto reducible, of which the oxide has the form of a black and very volatile powder, very odorant, very fusible, soluble in water, and rising with it in vapour, and giving a strong smell and taste to that fluid. Its solution assumes a fine blue colour by the smallest quantity of infusion of nut galls.

The singularity of this composition is no less worthy of remark than the sagacity by which it has been developed.

Discovery of chromium in meteoric stones. Chromium has lately been discovered in the meteoric stones by M. Laugier, and since by Mr. Thenard.

Whether the composition of muriatic acid, announced by Pacchiani, can be depended on. The discovery of Pacchiani, of the formation of muriatic acid, by galvanism, is considered as in want of confirmation, since Messrs. Biot and Thenard did not find it when they took care to make the experiment without the presence of any thing which could afford sea salt. The experiments of Mr. Sylvester, recorded in our Journal, Vol. XV. p. 50, however appear to confirm the fact, and conduce not a little to explain the process, which no doubt must be considered as still enveloped in obscurity.

Curious and useful researches of Biot upon refraction. In a series of researches upon refraction, undertaken in the first instance for the improvement of astronomy, M. Biot was led to avail himself of this action of bodies upon light as a very happy means of analizing transparent substances.

It has been long known that the rays of light are refracted when they pass from one medium into another of different density, and that the refractions of different mediums correspond with their densities, unless they contain some combustible element. These last increase the refraction much beyond what the simple density would have produced.

From this antient observation it was that Newton formed a judgment that the diamond must be combustible, and he even arrived at the almost incredibly acute conjecture,

jecture, that water must contain some combustible matter.

The proportion of parts in known compounds, if transparent, may be determined from their refractive power.

If two substances be mixed of known refractions and proportions, and regard be had to the density of the mixture, the total refraction may be calculated; and, on the other hand, when the refraction of a mixture of which the elements are known is ascertained, their proportion may also be had. Mr. Delambre, in his report, explains the principles of this calculation.

Mr. Biot having applied it to mixtures of known proportions, and having always found it just, has made use of it to determine the unknown proportions of other mixtures.

Method of making the experiment

For this purpose it is only needful to fill a prism of glass, under a known pressure, with the substance intended to be examined; or, to form a prism of it, if it be solid, through which a remote object is to be observed; the angle of refraction is to be measured with the circle of repetition, keeping an account of the pressure, the heat, and the humidity of the external air; and this method being susceptible of a precision equal to that of astronomical processes, necessarily surpasses all our chemical processes in accuracy. But it must also be remembered that it is applicable only to transparent substances, of which the principles are known as to their nature or species.

particularly applicable to the gases.

It is particularly useful to give perfection to the analysis of gasiform substances, and Mr. Biot has already obtained interesting results in this respect.

Oxigen refracts the least, and hidrogen the most, at equal densities. The refractions of the same gas are strictly proportional to its densities when the temperature is constant. Strongly refracting substances appear to owe their force particularly to hidrogen, for they all contain it. Atmospheric air gives exactly, by experiment, the refraction which, according to calculation, ought to be produced by a mixture of 210 oxygen, 787 azote, and 3 carbonic acid. The application of the rule is found to hold not only in simple mixtures, but in more intimate combinations, provided no very considerable condensation has been produced. Thus ammoniacal gas

Common air and other gases tried.

 produces

produces the effect indicated by the quantities of azote and of hydrogen which enter into its composition; but if the condensation be too great, there is some alteration though very small. Such is the case with water.

Muriatic acid gas.

The examination of muriatic acid gas, made after these principles, shews that its radical cannot be azote; and also that it cannot be an oxide of hydrogen, containing less oxygen than water.

The diamond inferred to contain hidrogen.

The refraction of the diamond being much stronger than that which is indicated for carbon by the refractions of carbonic acid, alcohol, ether, and other substances of which carbon makes a part; M. Biot concludes, that the diamond cannot be pure carbon, and that we must admit at least one-fourth of hydrogen to satisfy the results of the experiment.

The examination of animal and vegetable products has been carried on with activity and effect.

New principle in asparagus.

The crystalline and soluble principle in asparagus, which is neither acid nor neutral, and does not affect the ordinary re-agents, has been discovered by Vauquelin and Robiquet. The account has already been inserted in our Journal. Vol. XV. 242.

Saccharine matter in bile.

M. Thenard, Professor of the College of France, has completely ascertained the existence in the bile of a saccharine matter which serves to keep the oily part in solution. His methods of analysis are such as do great credit to his sagacity.

Component parts of coffee.

Seguin has made experiments on coffee, which he finds to consist of albumen, oil, a peculiar principle which he calls the bitter principle, and a green matter which is a combination of this last with albumen. He finds that the proportions vary in different specimens; that torrifaction augments the proportion of the bitter principle by destroying the albumen; that these two last principles contain much azote; and that the bitter principle is antiseptic. The oil of coffee is without smell, congelable, and white.

Mr. Seguin has discovered albumen in a great number of other vegetables, and most of them contain a bitter principle, in some respects similar to that of coffee.

Albumen in vegetables.

From the remarkable quantity of albumen found in vegetable

vegetable juices which ferment without yeast, and afford a vinous liquor, this chemist was led to inquire whether the albumen might not be of essential consequence to this intestine motion which is still so little understood. He assures us, that having deprived these juices of albumen they became incapable of fermenting, and that having artificially supplied this principle, such, for example, as white of egg to saccharine matter, the fermentation took place when other circumstances were suitable, and a matter similar to yeast was deposited which appeared to him to be only the albumen which was altered so as to be nearly insoluble without having lost its fermentescible action. Hence he concludes that albumen, whether animal or vegetable is the true ferment.

—is the principle of fermentation.

Mr. Seguin has further ascertained that albumen is found in three different degrees of insolubility and disposition to become fibrous; that the more it is soluble, the more powerful is its action; that the respective proportions of albumen and of sugar in the different juices determine the vinous or acetous nature of the product of fermentation, the product being more spirituous, the greater the quantity of sugar; and lastly, that most of the fermentable juices contain a bitter principle analogous to that of coffee, which is of no effect in the fermentation, but contributes to the taste and preservation of the fermented liquor.

Interesting facts relating to fermentation.

Tannin, the vegetable principle formerly discovered by Seguin, and of which the character is to form an insoluble compound with gelatine, has been again examined by Bouillon la Grange, Professor at the Napoleon Lyceum. He has found that it has an affinity for the alkalis, the earths, and the metallic oxides, and the faculty of becoming converted into gallic acid by absorbing oxigen.

New facts respecting tannin.

The tannins extracted from different vegetables vary a little in their composition; and that which was discovered by Mr. Hatchett, of London, in such great abundance in cachou is rather more oxigenated than the others.

An Italian chemist, Morichini, having discovered fluoric acid in the enamel of the fossile grinders of the elephant, analized the enamel of human teeth, and supposed

Fluoric acid in fossil teeth.

posed he had obtained the same principle. Mr. Gay Lussac finds it likewise in ivory, as well when fresh as when in the fossil state, and also in the tusks of the boar.

Messrs. Fourcroy and Vauquelin have repeated these experiments, and have, in fact, obtained this acid from tusks and teeth altered by their continuance in the earth, but not from the same parts when fresh, nor even in those which were fossil and had undergone no change.

The experiments of Vauquelin upon hair have already appeared in our Journal. Vol. XV. 141.

The nature of Roman alum explained.

Clement and Desormes have made experiments to imitate the Roman alum, in which they have perfectly succeeded in the large way. Their method consisted in calcination and recrystallization, which afforded an alum deprived of part of its superabundant acid. Curaudeau asserts, that it is also necessary that the small quantity of iron usually contained in alum should be oxided to the maximum for this purpose. But in a later memoir Thenard and Roard appear to have completely disposed of the subject. They have ascertained that one thousandth part of iron has an influence on the effect of alum in dying; that the efforts of the alum maker ought to be directed to clear this salt from that minute quantity; that the oxigenation produces this effect by rendering the iron insoluble; and lastly, that well purified alum is of equal value for manufacturing processes with that of Rome.

Fumigation by oxi-muriatic acid.

The application of the oxygenated muriatic gas to prevent the effects of contagion, as pointed out by Guyton, has been strongly confirmed in the hospitals of France; and it is asserted to have produced the happiest effects as a preservative against the yellow fever in Spain.

Anatomical notices.

Many interesting anatomical researches by Turpin, Cuvier, Tenon, Laumanier, Pictet, Duvernay, Damas, and others, have enriched the year preceding the session of July last.

The report concerning the mathematical transactions of the Class of Science was given by Delambre.

The antient measure of a degree in Lapland was erroneous;—

In the question which has arisen on the subject of the new measure of a degree in Lapland, in which the cause of the error committed in 1736 is required to be ascertained,

tained, Mr. Lalande has sought in his long experience for facts which might answer that purpose. He has remarked, that at that time the use of the telescope of verification (lunette d'épreuve) was entirely unknown. This very commodious and simple instrument, which might be supposed of as early an invention as the application of telescopes to sectors and quadrants, is more modern than might be imagined. We possess the advantage of this, as well as of many other articles of daily use, without inquiring after their inventors. It is mentioned for the first time in the edition of Lalande's Astronomy, of 1764. In order to verify the parallelism of telescopes, Bouguer adopted the use of two pins or studs, which were mutually to be changed in place, in order to ascertain whether they had really the same height. He himself made use of a more imperfect method, which is still less entitled than the studs to be put in competition with the proof telescope of Lalande, which is at present universally adopted. We do not know whether Graham had some equivalent method of approximation to verify his sector. Maupertuis makes no mention of any such thing in the chapter wherein he treats of the verification of that instrument, and this neglect may in part explain the error which is imputed to him.

—because the telescope of verification was not then known.

Mr. Legendre has been busied upon a question of importance, though of rare application. His memoir is entitled, "Analysis of Triangles traced on the Spheroid."

Spheroidal triangles treated by Legendre.

The early astronomers who measured the earth with some exactness, considered it as a sphere of immense radius, in comparison with the small intervals they proposed to ascertain. The greatest side of any triangle in these operations does not exceed 60,000 metres, and the difference between such an arc and the right line that would connect its extremities, is scarcely two decimeters, or the three hundred thousandth part. It was therefore, with reason, supposed that triangles of so minute a curvature might be considered as right lined.

In the latter operations wherein it was sought to determine more exactly the difference between the terrestrial globe and a perfect sphere, an attention to accuracy was carried farther. The triangles formed at the surface

of

of the earth were considered as very minute portions of a sphere, which, in all the extent of each triangle was confounded with the spheroid.

Does this supposition, though less inaccurate than the preceding, promise all the precision which it seems fair to expect from it? and since it is a spheroid which is to be measured, why not calculate the triangles as spheroidal? This question is so obvious that it must at once have offered itself to the astronomers charged with the operation, and to each of the learned men, united from the different parts of Europe, to examine and form a judgement of the work which had been executed. In one of the first meetings of the commission, a learned foreigner, M. Tralles, remarked that the bases of Melun and Perpignan could not be simply considered as arcs which should be throughout in the same place, but as curves of double curvature. This remark was made by Clairaut above fifty years before; but it was always thought that the effect of the double curvature could not become even a little perceptible, unless upon intervals much greater than we can directly measure; and it was concluded that considerations of the spheroid would only add an useless degree of complication to calculations already too complex. In fact, the spheroid differs from the sphere much less than the sphere itself does from a plane. Now the sphericity of the triangles does not introduce any terms into the calculations but those of the second order for the angles, and of the third for the sides. It was therefore natural to think that the terms dependant on the spheroid would be of an order more elevated, and still less sensible on account of their extreme minuteness. But no one yet had written on the subject; it was not to be supposed that the astronomers would rest contented with vague considerations and a simple probability. This point, they inform us will be found discussed in the article "Calculation of the Triangles," in the second volume of the Meridian, at present in the press; in which it will be demonstrated, from considerations of great simplicity and elementary throughout, that the difference between the spherical and spheroidal angles of the greatest of their triangles, is not one sixtieth of a second, and that the double

double curvature does not change the longest of their sides nearly so much as one centimetre. These results are confirmed by anticipation in the learned analysis of Legendre.

[The Conclusion of this Report in our next.]

University of Gottingen.

The foreign Journals give accounts of the new modeling of the constitution of this University, under the Prussian government, which the disastrous events of war have since shaken to its centre. I shall not copy this part of their intelligence, so little likely to be permanent, but shall confine myself to the notice of the first part of the Meteorologic Researches, which Professor Mayer has read to the Society.

Mayer on planetary affinity or influence.

In this paper he treats of the chemical affinity of the heavenly bodies, or the influence they appear to exercise upon each other independent of gravity, which influence is manifested in their atmospheres. He particularly attends to that of the moon upon ours, which leads him to treat of globes of fire, and stones, said to have fallen from the sky. He remarks, that almost all these phenomena have taken place when the moon was near one of its nodes, and in that half of its orbit in which its light is on the wane. In the cases which seem to oppose this observation, the coincidence of the passage of the moon through one of these nodes, with its last quarter, took place the preceding lunation. Thus it was in 1803, in the lunation which preceded that of the shower of stones at L'Aigle.

Academy of Useful Sciences at Erfurt.

Ore of platina.

In the ordinary sitting of the Academy of Useful Sciences at Erfurt, on the 4th of March, M. Bucholz presented a memoir, transmitted by M. Tromsdorff, intitled, " New Experiments to afford a more accurate knowledge of the Ore of Platina." The author endeavours to

 reconcile

reconcile the contradictions of the English and French chemists relative to this metal. After a long series of experiments, he has found that Platina, in its crude state, contains also four other metals, osmium, iridium, rhodium, and palladium, and he gives the characters of each.

Iceland crystal. Professor Bernhardi communicated some researches on the double refraction of Iceland crystal, or the crystallized carbonate of lime, in which he has noted the phenomena with greater precision than has hitherto been done.

Lycopodium. M. Bucholz communicated the results of his experiments on the seeds of Lycopodium, which afford new views respecting this vegetable product. 1. The seed of lycopodium contains one-sixteenth part of a fat oil, of a brownish yellow colour, and soluble in alcohol. 2. A portion of true sugar. 3. A viscid extract, of a brownish yellow colour and insipid taste. 4. The residue, after treatment with alcohol and water, appears entitled to be considered as a peculiar product of the vegetable kingdom. 5. The yellowish appearance of the seeds in this last state, appears to indicate the union of a kind of pigment with the first principles of the seed, or at least a very intimate union of the constituent parts of this seed. 6. It is the oily part that enters into the composition of this seed which renders it so speedily combustible, and causes it so immediately to separate from water.

Wirtemberg.

Prize for the best theory respecting fossil bones. M. Caula, Banker to the Court of Wirtemberg, has offered a prize of 150 florins (13 guineas), for that explanation which shall be judged the most satisfactory on the subject of the fossil bones continually found in the kingdom of Wirtemberg. It is not simply a critical dissertation which is expected on the different opinions relative to the events which may have transported these remains of the animal kingdom into the places where they are now found; but it is most particularly desired that some elucidation should be given from the chemical decomposition and connection of these bones. It is desired also, that a deduction should be made of the cha-

racteristic

racteristic epochas of their existence from the geologic proportions of the successive or gradual strata in which they take their origin, in order to establish upon those data a better judgment than has heretofore been made concerning the revolutions our globe may have been subjected to with regard to the animal kingdom. It will therefore be necessary, for the accomplishment of this purpose, to endeavour to collect into determinate species the animal skeletons at present come to our knowledge, to shew the identity and the differences of these skeletons with respect to living animals; and lastly, to assign to the species, considered as extinct, the rank which they ought to hold in the natural history of the animals still existing on the face of the earth.

Planetary Epocha.

M. de Lalande received, in the month of April last, an anonymous letter, from Franckfort, in which it was said that a German of high reputation in several sciences discovered, fifty years ago, a remarkable period of 280,000 years for the return of the six planets to the same point of the heavens, and his opinion thereon is requested to be given in the Magazin Encyclopédique of M. Millin. The number of revolutions found by the German astronomer for each of the planets have been reduced into seconds by Lalande from the revolutions as at present known, and are as under:

Planetary epocha of 280,000 years.

Mercury....	1162577	8836135098921.
Venus......	455122	8835595689448.
Earth......	280000	8835940680000.
Mars......	148878	8835946519500.
Jupiter....	23616	8835946544448.
Saturn......	9516	8835946558608.

M. Lalande remarks, that these numbers differ so little that the deviation from the same precise number of seconds in each sum of revolutions is not greater than the uncertainty in the known durations of those revolutions. He therefore considers the return of the planets in 280,000 years as a curious result, and is desirous of knowing the name of him who had the courage to make such long calculations.

Solar Spots.

Solar spots.

M. Hultz, a Prussian Astronomer, of Frankfort on the Oder, has published an opinion, in August last, that the sun at that time was undergoing a considerable change. His opinion was founded on a number of spots occupying one-fifth part of its diameter in their length and one-nineteenth in their breadth. These spots varied in their form, and were perceptibly changed in the course of two or three hours.

To Mr. Nicholson.

Sir,

I shall feel particularly obliged to some of your numerous correspondents for information, through the medium of the Journal, respecting the manner of dissolving the elastic gum (*Caoutchouc*) so as to render it applicable to form a coat on silk, &c. for surgical purposes.

I am, Sir,

Your obedient servant,

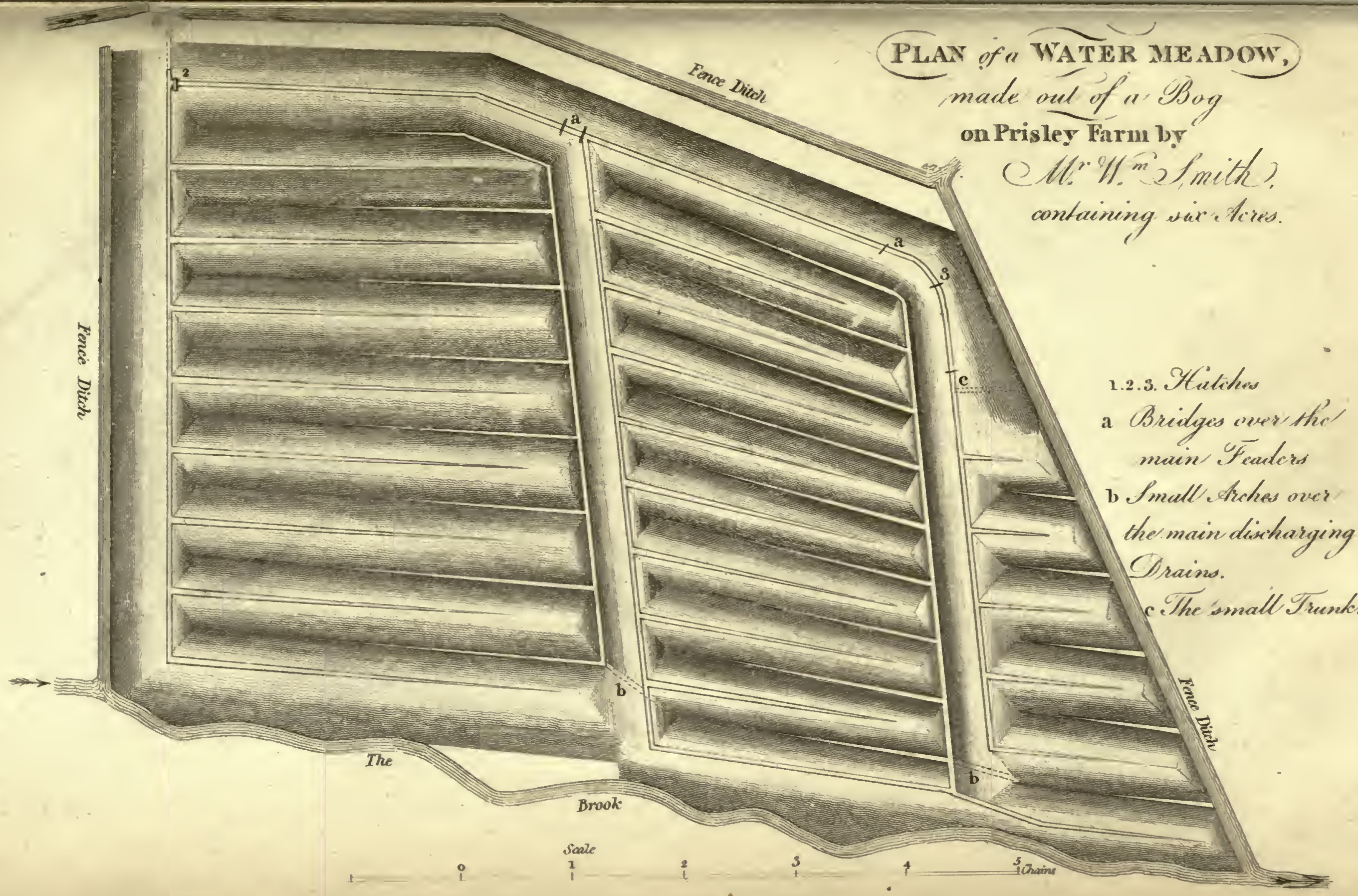
A CONSTANT READER.

Nov. 7, 1806.

RECORDS OF LITERATURE.

The prospectus of a new periodical work has just been circulated, entitled, Records of Literature; it is intended to present a general statement of the progress of knowledge in all its departments; and, by giving a brief account of all works announced or published, to form an Index to the Literature of the World.

I will examine the principal chemical laboratories, and if the subject should appear of sufficient novelty, after the general descriptions of Lewis, Macquer, Lavoisier, Brisson, and others, I will give a notice as requested by our correspondent X. Y.


PLAN of a WATER MEADOW,
made out of a Bog
on Prisley Farm by
Mr. Wm. Smith,
containing six Acres.
1.2.3. Hatches
a Bridges over the main Feaders
b Small Arches over the main discharging Drains.
c The small Trunk.
Fence Ditch
Fence Ditch
Fence Ditch
The Brook
Scale
0 1 2 3 4 5 Chains
a
a
b
b
c
2
3

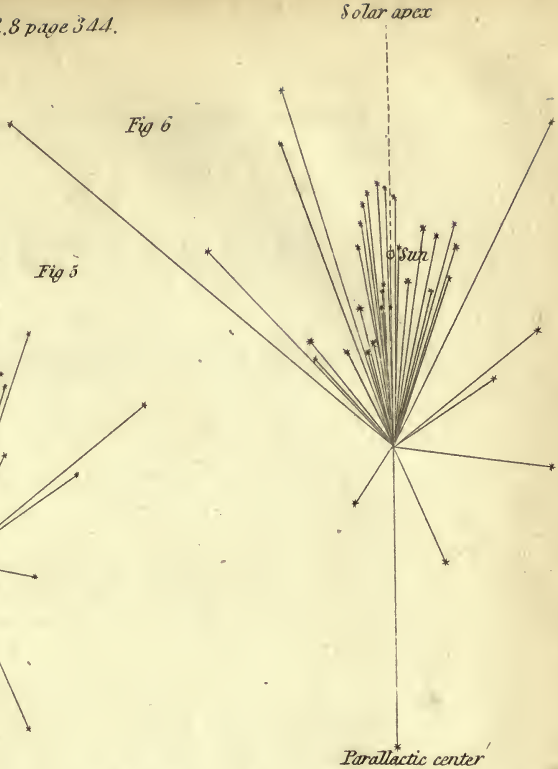


Fig 6

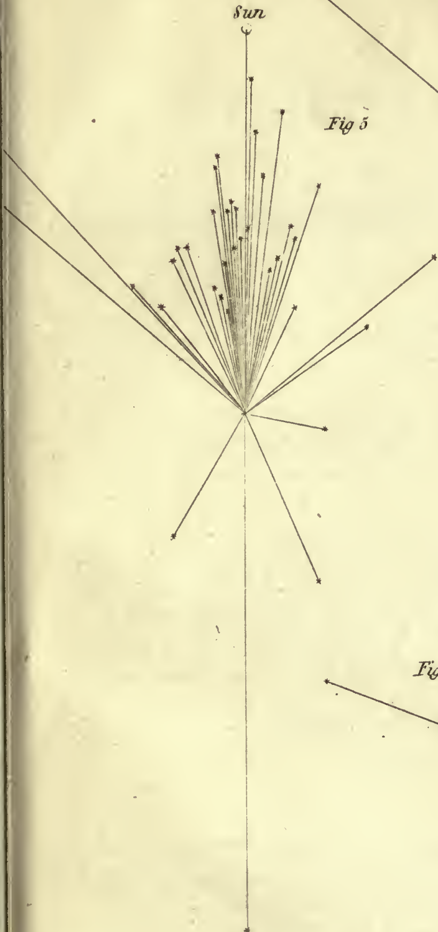


Fig 5

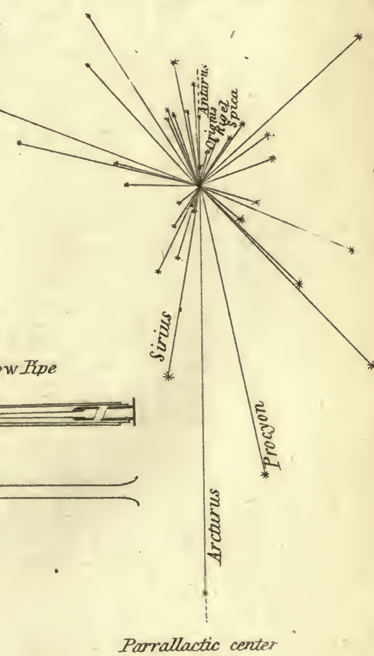
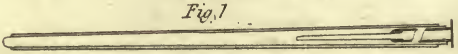


Fig 4

D^r Wallastons Blow Pipe

Fig 1



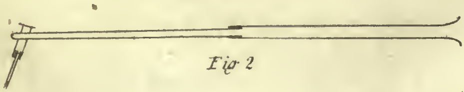


Fig 2

A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND

THE ARTS.

SUPPLEMENT TO VOL. XV.

ARTICLE I.

Observations and Experiments to shew that the Effects ascribed by Mr. Dispan to the perpendicular Descent of Hoar Frost are not so general as to support his Theory. In a Letter from JOHN GOUGH, *Esq.*

To Mr. NICHOLSON.

Middleshaw, Dec. 8th, 1806.

SIR,

AN ingenious memoir on congelation in Spring and Autumn appeared in your Journal for November; in which the writer, M. Dispan, mentions certain experiments on the authority of a Parisian philosopher. He was informed by this gentleman, that if several plates of water be exposed to the air in a frosty evening, one of which is covered with a pane of glass, &c. the water in the open vessels will freeze, but the contents of the covered plate will remain fluid. The same person also observed, that if a funnel be suspended in the evening, at a moderate distance, over a plate of water broader than itself,

Dispan on the congelation of water exposed to the air in the night.

itself, a ring of ice will be found adhering to the circumference of the plate in the morning; but the water immediately under the funnel will retain its fluidity.

Experiment to determine whether the freezing is effected by an action perpendicularly downward.

The perusal of M. Dispan's ingenious essay brought several facts to my recollection, which rendered the accuracy of the preceding narrative somewhat disputable; but memory too frequently preserves the outlines of events, while she neglects to record collateral circumstances of importance; I therefore resolved to try the merits of the Parisian's relation by experiment the first opportunity. This design was soon accomplished; for a suitable occasion presented itself on the 21st of November. The evening was perfectly calm; and I found the copper funnel of a rain gauge slightly incrusted with hoar frost at 7 P. M. A saucer, containing water, was immediately placed upon a stand in the middle of a garden, one half of this vessel being covered with a pane of glass, while the other remained exposed, and the distance of ¼ of an inch separated the glass from the water. The evening proved very favourable to the experiment, for hoar frost fell copiously upon slender bodies, such as gates and pales, as the night advanced, but the gravel walks of the garden remained wet at 11 P. M. The saucer was visited at this time, when it was found perfectly covered with a film of ice, and both sides of the glass were incrusted with rime. The film on the saucer grew thicker in the course of the night; but the vessel of water which stood upon the sole of a window in the garden remained unfrozen in the morning.

It did not prove so.

The facts indicate that the superior temperature of a dwelling house impedes freezing on the ground near it.

Were the preceding remarks submitted to the consideration of M. Dispan's friend, perhaps he would say, that the lintel of the window protected the vessel standing under it from the frigorific particles, by interrupting their perpendicular descent; consequently the water retained its fluidity, being sheltered from the influx of those minute bodies which constitute the true cause of congelation. The experiment might also be rejected by the same philosopher not without some shew of reason, for it evidently answered his expectations in one instance, though it disappointed them in another. The same objections may be urged, with equal effect, by those who suppose that

that congelation is caused in Spring and Autumn by hoar frost falling perpendicularly from the atmosphere; but the morning of the 22nd exhibited appearances which reconcile the apparent contradictions of my experiment on very different principles. The roads were dirty, in consequence of a week of very tempestuous weather, and the surface of the mire upon them was slightly frozen; but the small collections of water and mud which were found near the house remained untouched by the frost, even in situations where the eves of the building could not protect them from the perpendicular descent of particles falling from the atmosphere. The foregoing observation induces me to conclude, that the superior temperature of the house counteracted the feeble effects of the frost to a certain distance from itself, and raised the temperature of a vertical stratum of air above the freezing point: now as the vessel stood on the sole of the window, on which my observations were made, it was wholly surrounded by this warm stratum; consequently, the water contained in it could not freeze, while the saucer in the middle of the garden was exposed to a degree of temperature lower than 32°.

Houses and walls do not heat and cool as quickly as the atmosphere.

I am farther convinced of the justice of this conclusion by having frequently found that houses and strong walls do not heat and cool with the same celerity as the atmosphere. This appears to be the reason why slight frosts are found to prevail in Spring and Autumn in the open fields, which do not extend their effects to towns; while, on the contrary, exposed roads are frequently observed to be wet and dirty after the conclusion of a fit of severe weather, at a time when the ground close to high buildings remains frozen. To prove that this was the real cause of the contradiction apparent in my experiment, I repeated it on a subsequent occasion with this addition: two Florence flasks were exposed to the air, one of them being suspended on a tree in the middle of the garden, and the other on the branch of a cherry tree near a pot of water standing in the window mentioned before. The flask in the middle of the garden was soon incrusted with rime, and a film of ice had been formed in the mean time upon a plate of water standing in the open

 air;

air; but the vessel on the window sole remained perfectly fluid, and the flask on the neighbouring cherry tree was only wet with dew, being untouched by hoar frost.

The Parisian experiments were probably made in favorable circumstances.

Several of the facts stated above are common occurrences, and they seem to reconcile the opposite results of my experiment with ease; we may therefore say, without hesitation, that the experiments of the Parisian philosopher happened to be made under circumstances which proved highly favourable to his hypothesis. I venture to make this assertion, because a saucer of water, one half of which was covered with glass, evidently comprises all his experiments in one; it also refutes them singly, by shewing that congelation took place under the pane of glass, as well as in the exposed part of the saucer. In order, however, to give an additional proof of a fact, which is almost demonstrated by common observation, I took the opportunity of a calm evening when the frost was very gentle, and placed a cup of water under a glass bell upon a stand in the middle of the garden; at the same time a circular plate of metal, five inches in diameter, was suspended horizontally over the centre of a vessel of water, which was considerably broader than itself; the distance between the plate and water was about two inches, but neither the bell nor the plate prevented their respective vessels from being covered with ice. It will now appear, that congelation is not caused in Spring and Autumn by adventitious particles of any kind falling from the atmosphere; on the contrary, vernal and autumnal frosts must evidently be ascribed to the common effect which is universally produced in water by a temperature less than 32°. What is still more to the present purpose, water may be concreted into ice, in circumstances under which the aqueous part of the atmosphere cannot be converted into hoar frost; so that there is no necessity to employ the latter production as an agent contributing to the formation of the other. The truth of what is here advanced will be proved by the following experiment, which I made some years ago:—

Water will freeze under a cover.

Congelation in circumstances where hoar frost could not be formed.

Having observed a quantity of wet woollen yarn to be frozen, which was exposed to a moderate north wind upon the rails of a wooden bridge, I suspended a thermometer

mometer in front of it, which did not descend lower than 34°. We have here an instance of congelation where hoar frost could not exist; but suspecting evaporation to be the cause, I had the thermometer dipped in water of 36°, and exposed it again to the breeze; upon which the mercury fell to 29.5°, and a film of ice formed on the bulb in a short time. Two small parcels of wet yarn were also placed in the same situation, one of them being inclosed in a corked phial, while the other remained exposed to the wind; the latter soon became stiff, but the former continued soft for the space of three hours.

The theory of M. Dispan not to be relied upon.

The experiments detailed in this letter have convinced me, and the same evidence perhaps may convince some of your readers, that M. Dispan's theory cannot be relied on; for water has been shewn to congeal without the assistance of hoar frost, when the freezing powers of the atmosphere are very feeble; which appears to be an unanswerable objection to the theory in question. As for the phenomenon described by M. Dispan, perhaps it is not very uncommon; at least I have known something similar occur more than once on a part of the river at Kendal, where the current is obstructed by a weir placed a little below a stone bridge. The expanse of water formed by this impediment is occasionally covered with a sheet of thin ice above and below the bridge in the course of a night of calm and moderate frost, when the river is low and nearly stagnant; at the same time no symptoms of congelation are seen under the arches. I have always attributed this singular occurrence to the same cause which preserved my water pots on the window sole from the frost; that is, I have always supposed that the superior temperature of the bridge prevented the two sheets of ice from uniting beneath it, nor could conjecture furnish me with another reason. M. Dispan's memoir, however, suggested new principles; and as there was a possibility of error on my part, I have endeavoured to throw fresh light on the subject by the experiments which are now submitted to your consideration.

I remain, &c.

JOHN GOUGH.

II.

Description of an Eight-day Clock, with an improved Striking Part, by Mr. Henry Ward, *of Blandford, Dorsetshire*.*

Improvement and simplification of the striking part of clocks.

THE striking part of this clock is so far simplified, that the whole train of wheels used in common clocks, together with the barrel and weight, are entirely superseded.

The power necessary for raising the hammer is obtained from the pendulum.

A A A A, Plate X. represent the front side of the frame. B, a cock in which rests the pivot of the pallet arbor. C, a brass arm firmly fixed on the same. D, the gathering pallet, and E, a thin plate of brass, both rivetted on the same collet, which turns on a small stud fixed in the arm C; this brass plate has two notches in it, at *a b*, in which acts a slender spring F, fastened to the collet of the arm C, by a small screw, and serves to keep the gathering pallet in its proper position. G, the cock of the hammer-bar. H, the hammer-tail, which acts also as a hook in the teeth of the rack. I, a brass arm, or rather a lever, which lies behind the minute-wheel N, and is fixed with the hammer-tail to the hammer-bar by means of a pin. K, the flirt. M, the rack. N, the minute wheel. O, the hour wheel. The bridge and snail are the same as in a common clock.

The operation of this work is as follows. A pin is fixed in the back of the minute wheel N, and as it revolves, raises the lever I, by which the hammer-tail H is lifted out of the rack, the rack is then at liberty to fall; the lever I, by bearing against the pin, returns gradually, and prevents the hammer from striking the bell.

Before the pin has quitted the lever I, another pin in the front side of the same wheel begins to lift the flirt;

* Communicated to the Society of Arts. See their Vol. XXIII.

when

when raised to a sufficient height, it is let go by the pin, and falls on the gathering pallet D, which forces it into the rack; it is prevented from rising out of the rack by the spring F, having got into the notch *b* of the brass plate E; the pallet immediately acts on the rack; for, as the arm C moves from left to right, it lays hold of a tooth, and carries it along with it by means of the *vis inertiæ* of the pendulum, at the same time the hammer-tail is raised by another tooth of the rack, and on quitting it the hammer strikes the bell; when the arm C returns with the gathering pallet from right to left, the rack is prevented from returning with it by the tooth resting against the end of the hammer-tail, the pallet is then carried over another tooth, and at the next vibration moves the rack and hammer-tail as before; thus they continue to act alternately on each other till the rack is up, and the clock makes one stroke regularly at every other vibration.

Improvement and simplification of the striking part of clocks.

Now, in order to disengage the gathering pallet, there is a pin fixed in the rack at *c*, and as soon as the last tooth of the rack has got past the hammer-tail, the shoulder of the brass plate E, which is rivetted to the pallet, strikes against the pin *c*, and lifts it out of the rack, the spring F jumps into the notch *a*, and prevents it from returning; thus it remains detached, and the pendulum continues to vibrate without any obstruction. The ball of the pendulum weighs about eight pounds thirteen ounces; and the weight 24 pounds. The clock has a dead scapement.

The objection that may perhaps be made to this clock is, that the striking part disturbs the isochronism of the pendulum; but whoever will take the trouble to try it against another pendulum, of the same length, both before and after it has struck, will find no sensible alteraation; and even if that were the case, the irregularities would be periodical, and return to themselves every twelve hours.

The advantages which I conceive this clock to have over a common clock, are as follow:

First—That it is not attended with that disagreeable roaring which is frequently heard in the wheels and pinions

Improvement and simplification of the striking part of clocks.

ons of others, and particularly the fly pivots when in want of oil.

Second—That the interval between the strokes is uniformly the same: the case is very different in other clocks, for as they get foul they always strike slower, and more so still when the weather is cold.

Third—That in consequence of its simplicity, it is not liable to be out of repair.

Fourth—That it can be manufactured for considerably less expense.

HENRY WARD.

III.

Description of a Model, for elevating and depressing Water, applicable to the use of Canal Locks, and for preventing the usual waste of Water therein, with Directions for working the same. *By Mr.* R. SALMON*.

Improvement to save water in canal locks.

IN Plate X. C is supposed to represent a canal lock of the common construction, whose lower gates *i*, *i*, open towards or into the lock, and its upper gates *k*, *k*, open towards the upper or higher level of the canal; D is a hollow caisson, or water-tight chest, which is fitted to a walled chamber or side-lock, so as to move freely up and down therein; *i* is an opening, which forms a connection between the lock and the caisson-chamber, and which can be closed by a shuttle fitted thereto, when required. Four standards, *e*, *e*, *e*, *e*, are firmly fixed on the ground and walls of the lock and chamber; and four posts, *c*,*c*,*c*,*c*, are fixed in the four corners of the caisson; on each alternate pair of these standards and posts the frames *a* and *b* rest, as on so many fulcrums, or moveable joints; the frame *b* (Fig. 1 and 2) has two straight parallel bars of thin iron fixed thereto, and standing up above the same; the frame *a* has two similar bars affixed to it, except that the

* From the Transactions of the Society of Arts, Vol. XXIII. The Silver Medal was awarded for this communication.

the top edges of these are hollowed into a curve, as shown in the figures. B A, is a carriage loaded with two heavy leaden weights, and resting on four low brass wheels, having grooves in their circumferences like sash pullies, to receive the iron bars upon the frames *b* and *a*, so that the carriage can be drawn along upon them; the distance of the axles of their wheels is such, that when the wheels at B rest on the frame over two of the posts *c*, *c*, the wheels at A shall at the same time rest over the other two posts *c*, *c*, as shown in Fig. 1; and when the wheels at B rest over two of the standards *e*, *e*, the wheels at A shall at the same time rest over the other two standards *e*, *e*, in Fig. 2. In order to work the model, the carriage must be brought into the position shown in Fig. 1, and this can readily be done by stops, which are provided in the proper places on the curved bars, for preventing the wheels from rolling too far; as much water must then be poured into the lock C, as will fill it exactly to the black line *d*, *d*, withinside the same; and if the table on which the model stands be not level, small wedges or chips must be put under the model where necessary, until the surface of the water exactly corresponds, all round the lock, with the top water-mark or line above-mentioned; it must likewise be observed, to place the model across the table, so that the weight *h*, when hung over the pulley *f* or *g*, may be at liberty to descend. Then hang the two-pound weight *h*, Fig. 1, by the line over the pulley *f*, at the upper end of the lock; and the carriage, or load B, A, will be drawn forward into the position shown at Fig. 2, and the water in the lock C will pass through the shuttle, to buoy up the caisson D, and its surface in the lock will descend to the lower level. Again, by shifting the weight to the lower end *g*, the load will again be brought back, the caisson depressed, and the water forced through the shuttle, again raised to the higher level *d*, *d*, in the lock, as in Fig. 1.

Improvement to save water in canal locks.

Hence it is evident that the water in the lock, with or without a boat therein, may be raised or lowered, by the application of any force to move the carriage or load, horizontally on wheels. That when it is intended to pass a boat from the upper to the lower canal, the water in the

Improvement to save water in canal locks.

the lock is raised to the top water-level d, d; the upper gates k, k, are then readily opened, and the boat floated into the lock; this done, and these gates shut, the water and boat, by withdrawing the load from the caisson, is lowered to the lower level of the canal. The lower gates i, i, are then opened, and the boat floated from the lock to the lower canal. In this operation of lowering a boat it is evident, that so far from there being a waste of water, a weight of water equal to the boat and its load is raised from the lower to the upper canal; for when the boat at the upper level first enters the lock, its own weight of water is displaced, and forced into the upper canal. And again, when it is floated into the lower canal, as much is again from that canal displaced, and forced into the lock.

On the same principle that water is gained by a descending boat, as above described, it will be observed, that no waste ensues in an alternate passage; and that in an ascending passage, a loss of water equal to the boat and its load only takes place.

It should be understood, that as canals are sometimes more or less full of water, locks on this principle must be constructed to raise and depress, to the greatest extremes that ever happen, from the highest high-water, to the lowest low-water mark, and that being so constructed, they will apply to any intermediate heights; the curved plane a being formed, to adjust and counterbalance the inclination of the wheels on the other plane b, thereby maintaining an equilibrium, at any intermediate height, which the water in the canal may happen to be at.

Having described its manner of operating, I shall explain and compare cause and effect; for which purpose it may be requisite first to state, that the load of the carriage B, A, is fifty-six pounds, which weight, when advanced, presses directly over the parts c, c, c, c, with all its gravity bearing on the caisson; but when the load is drawn forward, it rests entirely on the fixed standards e, e, e, e, and by this change the whole effect is produced.

Now, if the model be set properly to work, it will be found, that a two-pound weight suspended over the pulley

ley at either end, will put the carriage in motion, and thereby raise or depress the water in the lock, and that to do so, the two-pound weight will descend sixteen inches. Hence, two-pounds descending sixteen inches, may be denoted the cause or power to produce the effect. Farther, it follows, that this two-pound weight descending sixteen inches produces the same operation as fifty-six pounds laid in the caisson would perform, and this sinking of the caisson D may be denoted the direct effect produced by the two-pound weight. The indirect and requisite effect being that of depressing or elevating the water in the lock C, and the comparison thereon will stand thus: the surface of a body of water, of an area of twenty-four inches by ten, is raised about four inches and a half by the power of two pounds descending sixteen inches; and, *vice versâ*, by reversing the power, the water is again depressed. Improvement to save water in canal locks.

The shuttle *i*, between the lock and the caisson chamber, will regulate the time of the ascent or descent of the caisson.

R. SALMON.

Woburn, 23*d April*, 1805.

CHARLES TAYLOR, Esq.

SIR,

In reading over the copy of the paper which I hastily drew up, and sent with my model, I observe that I omitted making any remarks on its applicability, improvements to be made in the carriage to facilitate the moving of the load, and on the different other ways, besides the one shewn in the model, by which it may be put in action.

It will readily occur to every engineer, that this sort of lock is not confined to the particular shape of the model, or to any particular form. The caisson chamber may be placed endwise to the lock; may be of any shape, and placed at a nearer or further distance, as may be required.

On comparing the length and movements of the frames in

Improvement to save water in canal locks.

in the model, with what may be required in practice, it will appear that the length of timbers at large will not be such but that strength sufficient may be obtained for any load. It is also evident, that, although the frames consist of only two bearers in the model, yet, at large, any number may be introduced, parallel with each other, and as many wheels as bearers.

In this operation the weight of the carriage itself contributes toward the effect, which in common cases is otherwise, as generally there is an objection to the great weight required to make a carriage sufficiently strong for any extraordinary purpose; and there is no doubt but, by an improvement of the carriage, it may be made to require much less than the power used in the present model. The mode I should pursue would be, to make the load in the wheels themselves, that is to say, the necessary load to produce the effect should be two solid iron cylinders, running on as many bearers as are requisite, and to have a frame or carriage for the purpose only of connecting the cylinders; by these means, the strength and friction of the axletrees would be reduced very much, and the means required then to perform the operation would be only to put the body in motion, and to overcome any little obstacle or irregularity, that the peripheries of the cylinders would meet with in their progress.

The advantage of rollers over wheels has been admitted, even where the peripheries of the cylinders were in contact with the incumbent weight resting on the top of them, as well as with the supporting plane below; but, in the case above suggested, they have more advantage, being only in contact with the upholding frames.

With respect to its operation, if any objections should be found to the great animal power that would at large be required, it will occur, that various other means may be used to put the carriage or load in motion; some without any loss of water, and others with a trifling loss, compared with what the lock holds. Thus, when the caisson is up, if by a cock a portion of water be let into it, the equilibrium will be destroyed, the caisson will sink, and the water in the lock be raised. Again, if by a pump, or other means, the water be returned from the caisson

caisson to the lock, the caisson will rise, and the load of itself recede, and this would be without waste of water. To put it in motion with a certain portion of waste, it is presumed, different ways may be found, as the introduction of a portion of water from the upper canal to the lock, or the discharging of it from the lock to the lower level, these would with management occasion the caisson to rise or fall; or, if a part of the load were made to shift farther from, or nearer to the fixed standards *e e e e*, it would thereby cause the action required, and perform the operation; and it is probable, that a better way than any here suggested would arise, should the thing be put in practice.

Improvement to save water in canal locks.

I am, Sir,

Your obedient humble servant,

ROBERT SALMON.

Woburn, *May 4th*, 1805.

CHARLES TAYLOR, Esq.

IV.

Observations, chiefly mineralogical, on the Shetland Islands, made in the course of a Tour through those Islands in 1803. *By Dr.* T. S. TRAILL*.

THE first land we made after passing Fair Isle, was the southern extremity of the Mainland of Shetland. We approached first to Fitful-Head; a bold promontory composed of micaceous schistus. Pass through Cliff-Sound for several miles. The western side of this narrow channel is formed by a chain of low islands, seemingly composed of micaceous rocks. The eastern side is formed by a ridge of hills, which in many places present craggy precipices of the same material. The rocks along this side are all micaceous. Where Cliff-Sound terminates in

Mineralogy of Shetland.

* Communicated by the Author to Mr. Patrick Neill, A.M. Secretary to the Society of Natural History at Edinburgh, from whose "Tour through some of the Islands of Orkney and Shetland" this article is by permission taken.

Scalloway

Mineralogy of Shetland.

Scalloway Roads, I found a micaceous rock, forming the shore for a considerable way, in which there were no particles of quartz visible: it was formed of thin plates somewhat bent or undulated. This kind is reckoned, I believe, very rare; the fresh fracture, if I was not deceived, had somewhat of a silky lustre, and the rock was uncommonly tough.

Part of Scalloway Roads, especially toward the west, is surrounded by micaceous rocks. From Mr. Scott's house, quite through the valley of Tingwall, the general rock is limestone, in which are no vestiges of any marine production, and which, from its vicinity on each side of the valley to micaceous rocks, I suppose, is *primary*. These limestone strata were in most places highly inclined. This valley is the finest in Shetland, both for extent and cultivation. There are two lakes in the midst of it; one of which is said to be fifty fathoms deep. Observe a rude pillar of a single block of granite erected near one of these lakes. Probably it is a Scandinavian monument. Ploughs are more used in Tingwall-parish than in any other part of these islands. All I saw had only one stilt, like the Orkney plough. The spade is much used in Shetland instead of the plough. The harrows I saw here had iron teeth on one side, and wooden teeth on the other.

After traversing half of this valley, ascend the hills to the eastward for Lerwick. Observe fragments of micaceous schistus and granite, as we ascended. Descend toward Elsvoe, by a steep road, where micaceous rocks were prevalent. Observe near the road a vein of *whinstone* traversing these rocks; it was visible but for a short way; it was dense, and dark-coloured. Ascend from Elsvoe a steril hill of micaceous schistus; pass several ridges of mountains covered to a great depth by peat-moss, which concealed all that could interest a mineralogist. On the top of a high hill, find great numbers of rounded nodules of granite, quartz, and micaceous rocks, which the rains have probably separated from a very coarse sandstone breccia, of which this hill is composed. This breccia appears at the surface, as we approach Lerwick, taking place of the primary rocks. The included nodules

Mineralogy of Shetland.

nodules become less in size near to the town, where there is no other stone, an argillaceous sandstone excepted, which is much used at Lerwick for building. The hills around Lerwick are in most places absolutely denuded of the peat-moss which had formerly covered them, but which is the common fuel; so that well might the Stirlingshire parson exclaim, "I see nothing but the skeleton of a departed country," when his eyes were directed to this scene.

Return to Scalloway in a day or two. West of Mr. Scott's house, find the micaceous rocks to succeed the limestone; veins of quartz often pervade these micaceous rocks, and sometimes large veins of red felspar. The micaceous rocks are succeeded, as we go westward, by granite, which forms the principal rocks of the western part of the Mainland. On the *Wart-Hill*, find in many places, where the surface was broken, bog iron-ore, arising from the decomposition of vegetables or of the rocks.

Sail by a coast partly micaceous, partly granitic, to Selivoe, where the bay was filled with innumerable medusæ. This name is a corruption of *Silvoe*, which signifies *herring-bay;* but no herrings are now taken in it. Walk from Mr. Barclay's manse to Bixetvoe, another deep bay that intersects this part of the island. The rocks here are of granite, gneiss, and micaceous schistus. These continue round the headlands, in a few places mixed with limestone, as far as Selivoe. The schistus is sometimes formed into millstones. It is curious, that the stones of the hand-mills, now common in Orkney, are of a similar rock, which has been said to have been brought from Norway for this purpose, in ancient times.

In crossing the micaceous hills from Sandvoe to Sensting Manse, find, on the summit of a hill, a large white rock, called *marble* by the natives. It is composed of very large masses of pure white felspar and white quartz, with here and there a little silver-coloured mica. It may be considered as a granite, in which the constituent parts are uncommonly large and distinct. The whole seemed to me to fill a vein in micaceous schistus; but of this I could not be certain, as the hill was thickly covered by turf and short heath.—In my walks around Selivoe, find

only

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only primary rocks, chiefly granite and micaceous schistus.

Sail for Foula. Pass grand precipices of red granite. Near the only landing-place on this romantic isle, (the *Thule* of the ancients,) the rocks are all micaceous schistus. North of the landing-place it is filled with garnets well formed, but none of them large. This schistus is of a silver colour for the most part, but I found it quite black in several places. I found also here dark-green hornblende rock in considerable masses. The shores on either hand, as we recede from the landing-place, gradually become bold, and the micaceous rocks give place to tremendous precipices of red granite. The island contains three hills; the highest is about 1100 feet high; precipitous toward the north-west, but sloping toward the south-east. Two of these hills seem as if, in some grand convulsion of Nature, they had been rent from top to bottom, and that one-half had been buried in the waves. The cliffs are very magnificent, and inhabited by innumerable sea-fowl. Among the short heath on the highest hill, find many nests of the *skua-gull* among the largest of the gull tribe, and so bold as to dart at us, and even strike us with its wings, when near its nest. Its colour is ash-grey; its body seems about the size of a small goose; its bill is more hooked than the common gull. The *skua* does not inhabit any other island of this group; it is found at the Ferroe Isles. Observe swallows in the valleys, the only ones we saw in Shetland. The natives say, that their ponies are the best in Shetland. The people seem intelligent and curious. They see the parson only once a-year, when he stays with them some weeks, officiates, baptizes children, and collects his dues. Observe many granite veins traversing the schistus, some of them two feet thick; all are very dense in their texture.

Sail for the Mainland. Pass *Papa Stour*. The north-west coast of this island is of a red colour, but I was not near enough to ascertain the rock. It is hollowed out into grand caverns, through which the waves rush with inconceivable fury, forming a sublime spectacle. Anchor in Hillswickvoe. Sail for Papa Stour in the long boat, but are forced into *Vementry*. Land on a beach

beach composed of rounded nodules of granite, hornblende, and hornstone porphyry. Toward the south end of the island, the rocks are red granite. The end next to the Isle of Mickle Rhoe is partly micaceous schistus, hornstone-porphyry, and hornblende rock. Mineralogy of Shetland.

Pass over to *Mickle Rhoe*, and observe the hornstone-porphyry on the end next to Vementry. A little way from the beach, find a cliff of compact felspar.

The island rises toward the west into vast precipices of red granite, much eroded by the fury of the waves, forming stupendous arches, that mock the feeble efforts of human ingenuity. We observed enormous masses, detached from the island, forming gigantic isolated columns of wonderful magnificence. In a valley that crosses near the middle of the island, find in two or three places black hornblende rock, and hornstone-porphyry, the felspar of which presents regular oval plates, in a dark grey ground, rising through the heath, which was often mixed with *uva ursi* *, used by the natives for tanning. On either hand, the hills rise abruptly, and vast precipices of red granite, entirely destitute of even moss or heath, overhang the valley. In some places, one granite rock was piled on another in horrible confusion, producing, as far as the eye can reach, an indescribably sterile appearance. Barren as this island is, its inhabitants are happy, compared to what they are in some other parts of Shetland. They are emancipated by the proprietor, Mr. Hunter of Lunna †, from the *slavery of fishing*,

* Arbutus uva-ursi. Bear-berry bush.

† *Note by* P. N.—I am sorry that the following extract from a pamphlet, published in defence of the Shetland landholders, should seem to derogate from the praise which Dr. Traill so candidly bestows on this gentleman.

In an " Answer to Vindicator," bearing to be printed at London in 1804, it is stated (p. 45), " Mr. Hunter has found it necessary and convenient to permit his tenants to return to *bondage*, as " Vindicator is pleased to denominate it, under a tacksman ; *and it* " *is effected without a murmur !*—I have the best evidence for averring, that when Mr. Hunter first proposed this change to his " tenants, out of more than 130 householders, only eight accepted " their *freedom*, and *he was obliged to summon all the rest to remove*, before

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of *fishing*,—a system fraught, as it is carried on in some of these islands, with the greatest injustice, most flagrant and infamous oppression, which scarcely less deserves the notice of the Legislature, than some branches of *traffic*, that lately accupied its attention. I say this from a con-

" fore they could be brought to try it, even for one year. He then " offered leases to all who would take them; only eight or nine " applied, and a greater number absolutely refused to take any."— " These circumstances," it is added, " are alone sufficient to con- " vince every unprejudiced person of the advantages of the old " system." It appears to me quite otherwise; and I would draw precisely the opposite conclusion. These circumstances seem to afford ample evidence, not only of the extreme indigence, but of the abject dependence of the Shetland tenantry; of the " stupid apathy"—the extinction of the British spirit of independence— which has here been effected by the old system; which must therefore be a bad one. Mr. Hunter, I must remark, seems to have proceeded in his experiment with too great haste, and thus not to have given it a fair chance of succeeding. I do not question the purity of his motives; but I think that it was rather rash, to summon *one hundred and twenty-two poor tenants* all at once to remove! I have been found fault with for endeavouring to subvert the established order of matters in Shetland; but the alterations which I suggested, I proposed should be *gradually* accomplished; I even expressly protested against *precipitancy*. My words were, (p. 102,) " In most cases the tenants are so poor, that, were the landlord, *at* " *once* to withdraw his aid, and leave them to manage as they best " could, many of them would probably perish for want." Again, (p. 103,) " Even if the size of farms were enlarged, and leases of " 19 years duration granted, unless manufactures were here and " there, at the same time established, it is not improbable that " many of the present cottars would either starve, or be compelled " to *indent* themselves to America." If, with these moderate sentiments, I incur the charge of being a " bawler about oppression," &c.; with what language of reprobation ought not *Thule*, if consistent, to declaim against his friend *Mr. Hunter*, who, *at once*, subverted the established order of a whole district, and by his *fiat* turned 122 tenants adrift!

The tenants of Lunna, it is stated, submitted to be replaced, under a tacksman " without a murmur." This was about 1803, or 1804. If I knew the author, I would ask him, whether they submitted with equal tameness to the arbitrary increase of the " whale fishing exaction" from one guinea to three guineas—which, as already observed, was effected (probably without Mr. Hunter's knowledge) by the tacksman of this district in 1805, but, according to my information, *not* without murmuring!

viction

viction of its truth. It is not now general: there are several proprietors in different districts, who have emancipated their tenants; but still it is in some places carried on, and prevents my giving unqualified praise to a people, among whom I met with the greatest hospitality and kindness.

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The valley terminates in lofty cliffs of red granite. The boat waited for us at a small beach, covered with granitic sand, over which two vast granitic rocks impend, which formed a grand, but rugged vista of naked rock, as we put off shore.

Arrive again at Hillswick-voe. Walk to Hillswick-ness, a promontory chiefly composed of silvery-coloured micaceous schistus, containing immense quantities of garnets, of a very large size: those that were in the upper layers were much decomposed; but below some of them were complete, and finely crystallized. On the west side, this bold headland is perfectly precipitous; but on the east side, in one place, it slopes toward the shore. At this slope, observe a vein of a light-green stone, (probably schistose talc), traversing gneiss. This vein contains most beautiful specimens of common actynolite, some pieces in fibres, others in pretty distinct six-sided prisms; in some cases approaching in lustre to glassy actynolite. The actynolite is imbedded in talc, and was found mixed with steatite. The serpentine is called *kleber* by the natives, who use it as an excellent substitute for metallic oxides in ointments. They apply this ointment to burns with success. Near this place, find black hornblende rock of great hardness; sienite, in one place, containing a large mass of silky-white felspar. A reddish-coloured hornstone-porphyry, in rounded masses, was scattered on the shore. Observe great veins of granite in some places, traversing the micaceous rocks. As we approach the junction of this promontory with the Mainland, gneiss is found succeeding the micaceous schistus. Some grand pillars are detached by the fury of the Atlantic from the sides of this *ness*; the height of these is equal to that of the adjacent cliffs, which impend so over their bases, as to impress the spectator

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tator with sublime emotions, not unaccompanied by fear.

Set out for *Rona's Hill*, the highest point of Shetland. Walk over a granite country to Rona's-voe; cross this long and narrow voe, and land at the foot of precipices of red granite, in which the hill terminates toward the south and west. The hill is at first heathy, but toward the top it becomes naked rock. Its top is a long ridge, covered with fragments of decomposed granite. I attempted to measure its altitude by a portable barometer. I observed the barometer accurately when at the sea-side, both before and after my ascent, and found it stood exactly at the same height at each time, from which I concluded that no material alteration in the pressure of the atmosphere had taken place during my stay on the mountain. The barometer fell when on the summit 15 tenths of an inch, but I had no thermometer, which is necessary to perfect accuracy *. From Rona's Hill, see to a vast distance around,—all the Mainland, near seventy miles long, Foula, Fetlar, Yell, Unst, &c.

Sail close to the promontory of Hillswickness, and observe a great many reddish veins, traversing the micaceous rocks which compose these awful cliffs. Some of them were apparently several yards in diameter.

Pass at some distance a stupendous, insulated, and inaccessible rock, called the *Drongs*. It appears somewhat like a vast ship under sail. It is of a red colour, like some granite cliffs at a considerable distance on the Mainland, the nearest rocks on shore being micaceous.

Pass Isle of *Doreholm*, another insulated rock, perforated by a magnificent natural arch, through which the distant shores of the Mainland were visible. The colour of this is similar to that of the Drongs. Both are probably either granite or wacken, similar to what Professor Jameson describes as found in Papa Stour. A sailor who had been the day before on the shores of the Mainland nearest Doreholm, brought me fragments of both granite and wacken, of a brick-red colour.

* Supposing the temperature 50°, the height here indicated was about 1400 feet.

Observe

Observe that the parish of *Northmaven* (which was not visited by Professor Jameson), is bounded toward the west by tremendous precipices of granite, similar to what compose Rona's Hills, presenting a strong barrier against the encroachments of the Atlantic ocean. Mineralogy of Shetland.

Pass *Ossa skerries*, lofty insulated rocks, apparently of reddish granite. Pass in a fog the Isle of Yell. Double *Ska*, the most northern point of his Majesty's European dominions. It is a small island, composed of gneiss, which forms shores of considerable boldness, and is only at a little distance from the Isle of Unst. Anchor in *Balta Sound*, *Unst.*

The shores around this fine bason are entirely composed of serpentine rock, and the beach is covered with fragments of the same. The neighbouring hills, some of which are of considerable height, are also serpentine, and in many places are totally divested of vegetation, (even of lichens), presenting to the wearied eye a naked waste, of an iron-brown colour. The shores, from Balta Sound to Norwick Bay, rise gradually into vast cliffs, all of serpentine, in which are frequently found veins of talc, lamellar actynolite, and common actynolite. Observed imbedded, in one place, a substance very like *Labrador Hornblende*, but was not able to force out a single good specimen, on account of the hardness of the serpentine matrix. In the bottom of the Bay of *Norwick*, the shores are low, and a curious striated micaceous schistus presents itself. The striæ are in parallel straight fibres, of a grey colour, with but little lustre, intermixed with small particles of quartz. Near the junction of the serpentine and schistus, close by the sea, in a serpentine rock, find fine specimens of talc in a vein. This vein also contained tremolite in quartz. The serpentine hitherto mentioned has an iron-brown colour, from exposure to the air; but the colour of a fresh fracture is generally of a dark-greenish grey. The striated micaceous schistus begins in the bottom of the bay, and forms part of the western side of it, rising into lofty cliffs, when it is succeeded by a rock containing large masses of whitish felspar, often crystallized in rude rhomboidal figures. This compound rock is by Mr. Jameson called

gneiss.

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gneiss. This rock constitutes the coast as far as *Burra Frith*, a bay very bold and broken on the east side, where there is a hollow called *Saxe's Kettle.* It is formed by an enormous mass, that seems as if separated from the Mainland, and afterwards joined at its extremities by the falling in of less masses. In bad weather the waves are driven with violence through a small opening toward the bottom, and fill the whole yawning chasm with foam.

The hills that lie between Norwick Bay and Burra Frith are composed to the top of the striated micaceous schistus above mentioned; and, though the highest on the island, are covered with coarse grass and mosses, while the serpentine ones, though inferior in height, are, for the most part, destitute of vegetation. Does not this imply the hostile nature of magnesian earth to plants in general?

At the bottom of Burra Frith, the same kind of undulated micaceous schistus, before seen near Scalloway, again presented itself. From Burra Frith, the coast westward is composed of gneiss and micaceous schistus. At *Hermaness*, the latter rock abounds, and often contains finely crystallized garnets of a large size. Saw one at a gentleman's house found there, which was nearly 1½ inch in circumference, beautifully crystallized, and of a pretty good colour. At Hermaness are said to be grand caverns, into which the tide flows, and which contain fine natural pillars. These pillars are conjectured by Mr. Jameson to be of *gneiss.* The heavy surf prevented me from exploring these caverns. Toward the south, the isle of Unst is less bold on its shores, and the rocks above described are succeeded by argillaceous schistus and sandstone. In crossing the island to Mrs. B.'s, find in the declivities plenty of bog iron-ore, and in one or two places both earthy and schistose chlorite.

The little island of *Balta*, forming one side of Balta Sound, is composed of serpentine of various shades of colour.

Sail for Lerwick: pass the bold coasts of Yell and Fetlar, and sail between Out Skerries and Whalsey; (for an account of these see Professor Jameson's Outline). Sail close under the stupendous *Noss Head*, a grand promontory

montory on the east coast of Noss Isle, composed of sandstone of different hues, hollowed out below into innumerable caverns, the retreat of myriads of sea-fowl, whose various pipes sound harsh discord when heard alone, but when united, form a solemn concert, a tribute of gratitude for that portion of happiness they enjoy. The island of Noss and its holm are composed of sandstone. Over a chasm between the island and the holm a strong rope is stretched, on which a basket is slung, in which the natives pass over to plunder the nests of the sea-fowl that inhabit the holm, and to carry over a few sheep.* There is an incorrect engraving of this place, and the method of passing in the basket, published in Pennant's Arctic Zoology, (and from that copied into the Encyclopædia Britannica), from a rude sketch taken by the late Mr. Lowe, an Orkney parson.

Anchor in Lerwick Roads: pass over to *Brassa*, an island composed of sandstone, and of a coarse breccia with a sandstone base, like that already noticed in the neighbourhood of Lerwick. The eastern shores of this island, where they are exposed to the ocean, are lofty precipices like Noss Head, but the southern shores slope gradually to the water's edge. In Brassa and Noss, the strata are not very much inclined.

Walk along the shore west from Lerwick toward Scot's-hall. The breccia and sandstone continue beyond the north-west entrance into Brassa Sound. The nodules imbedded in the former are larger than in that found near Lerwick. As we go more westerly, the primary rocks again make their appearance. Leave the shore, and cross some hills, on which we observed micaceous schistus, gneiss, and hornblende rock. Descend into the northern end of the vale of Tingwall, where we again find limestone. Return to Lerwick by the manse of Tingwall, and pick up in several places fragments of striated micaceous schistus, but not so remarkable as that found in Unst.

Set out in the long-boat to coast the eastern sandstone shores of the Mainland. The coast from Lerwick for some miles seems to be of sandstone or breccia, and is perforated in many places by caves formed by the sea,

and

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and into some of these we rowed for several hundred feet. Soon after, we land, and find a compact limestone, interspersed with veins, or reddish calcareous spar, to succeed the sandstone. As we advanced, the hills on our right became higher, and were composed of micaceous schistus, especially at Coningsburgh. From this point they gradually fell in height, and sandstone of a dirty brown colour succeeded.

At *Sandlodge*, in 1803, (when I was there), a copper-mine was wrought, which has, I understand, been since given up, but which, I have been told, it is in contemplation soon again to open. There was then a small but well-constructed steam-engine on it. The principal shaft was sunk within a few fathoms of the sea. The miners had penetrated to the depth of about twenty-two fathoms, and were but little incommoded with water. The upper rock was sandstone; and below it, at twenty-two fathoms, lay a petrosiliceous, or perhaps quartzy rock, traversed by many veins of brown quartz. This was the greatest depth to which they had then penetrated; and I believe that the hardness and unpromising nature of this rock, was the cause of their so quickly giving up. At that time, there were but two Cornish miners, besides a Cornish *Captain of the Mines*, engaged, and these were chiefly occupied in giving directions to the natives employed to work in the mine. The want of men sufficiently skilled in mining, was certainly one cause of their failure. The principal manager was a partner, who had chiefly directed his attention to the corn-trade, as I was informed, and who was totally ignorant of the art of mining. The principal *lode* or vein lies between the sandstone and the petrosiliceous rock, in a direction from N. E. to S. W. The copper-ore is chiefly green carbonate, and the sulphuret; it is imbedded in an iron-ore, which is sometimes pulverulent, and was called by the Cornish miners *gozzan*. The iron-ore is by much the most abundant. When Mr. Jameson visited this place, the copper-mine was not opened; and he only mentions iron-ores as the product of the mine, which many years ago had been wrought by an English iron company, but afterwards abandoned. It was subsequent to Mr. Jameson's

son's visit that the copper-ore was much noticed. The iron-ores here found, are, Mineralogy of Shetland.

1. Dark-brown, fibrous, and mamillated hæmatites;

2. Columnar bog-iron ore;

3. Micaceous iron-ore;

4. Iron-ochre of a brown colour;

5. Stalactitic iron-ore, colour dark brown;

6. Earthy matter, much charged with iron, seemingly arising from the debris of other ores.

The copper-ores are,

1. Friable and amorphous carbonate of copper, colour rich green;

2. Beautiful carbonate of an emerald green, crystallized in capillary fibres of a silky lustre, diverging in radii from the centre. This species is found imbedded in iron-ore.

3. Sulphuret of copper, disseminated through felspar in some places, and, in others, in great masses in iron-ore.

The rich carbonates were found near the bottom of the mine. The levels and shafts of the old company seem to have passed within three or four feet of this rich vein, but never to have touched it. I walked through the galleries scooped out in former attempts for about forty fathoms, but saw only little appearance of copper ores, while there was iron in abundance all around. The roads near the mine were all paved with fine iron hæmatites, which the Cornish miners who were there did not seem to regard as of any value, nor indeed almost to know. Some of them imagined it was a new kind of copper-ore. Some pieces of bog iron-ore I had collected, were called *copper-spume* by one of them; hence, it is evident, we cannot trust much to the mineralogical opinions of the generality of miners. From the saline taste of the waters of the mine, and the crust of copper it left on my knife, I proposed to the workmen to try to procure *copper of cementation* in the usual way. This company had already expended between £9000 and £10,000 on the work, and had shipped one or two cargoes of ore; for, when dressed and washed, it was carried to England to be smelted. I was informed, that the

 best

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best of it sold for £70 per ton. The hills in the vicinity afford both copper and iron pyrites in considerable quantity. Near *Coningsburgh cliffs*, a vein of copper pyrites was wrought a few years ago, which yielded Mr. Jameson 18 per cent. of copper; but it so much decreased in width as they descended, that it was finally abandoned. The appearance of the ores, was judged, by the Cornish miners, to improve as they descended in the Sandlodge mine; and, at their lowest level, the quantity of fibrous malachite, when I visited the mine, was such as to afford a most beautiful spectacle by the light of our candles. They have since, however, I am told, unfortunately met with such obstacles, as to induce them to give up the work. Still, it appears to me, that it would be worthy the attention of some mining company, who had capital and enterprize to prosecute the undertaking.

Rocks of sandstone and breccia from the east coast from Sandlodge to Sumburgh. The micaceous hills now cross the Mainland, toward Fitful-Head; and from Quendal Bay to Sumburgh Head, the chief mineral production is sandstone. At *Quendal Bay*, a copper-mine was discovered several years ago, and was, in 1803, slowly worked by a very few miners. In the tract from Sandlodge to Quendal Bay, there are many indications of metallic ores, chiefly iron.

From Levenwick Bay, sail along the shores of the Mainland to Sumburgh Head, the southern extremity of these islands. It is composed of sandstone cliffs, moderately high. Am informed, that a slate quarry has been lately opened, not far from the top of this promontory—Bid adieu to Shetland.

With regard to the general distribution of the rocks which compose the Mainland, the western side of it is composed of micaceous schistus and granite; and is much more bold than the eastern, which consists chiefly of sandstone, and sandstone breccia. The parish of Northmaven contains most granite; and, if I am not mistaken, Rona's Hill, the highest ground in Shetland, stands in this parish. A similar distribution of the strata is, I believe, pretty generally observed in most countries, but

the

the cause has not been well explained. All the theories on the subject are lame and unsatisfactory. In the other Shetland isles which I have examined, the western coasts are generally the most bold, and are composed of rocks more indisputably belonging to that class called *primitive*, than those on their eastern shores. The same remark may be extended to the sister isles of Orkney, and even to Great Britain. Mineralogy of Shetland.

Preston's chart of the Shetland islands, is the only tolerable one we have: but it is inaccurate in the northern part, which, I have been told, he did not live to survey. The southern parts of Shetland were laid down by himself, and are extremely accurate; but the northern parts were carelessly added by some inferior hand at his death. I have even seen a small island or rock that is always uncovered, which is not in the chart at all. Mr. Jameson's small map is pretty correct. It would certainly be worth the attention of Government to cause a nautical survey of these islands to be made, with the same minuteness and accuracy that the Orkneys are laid down in the admirable charts of Murdoch Mackenzie. Pinkerton, in his Geography, seems to have supposed, that the Orkney coasts are as ill laid down as those of Shetland. He says, "We have better charts of the "coasts of New Holland than of the Isles of Orkney "and Shetland." Strange, that he should be unacquainted with *Mackenzie*'s *Charts*, which every vessel that sails the North Sea invariably carries!

V.

Facts toward forming a History of Silver. By Professor PROUST*.

THE muriat of silver is soluble in muriatic acid; it separates from it in octahedral crystals. This solution Muriat of silver soluble in muriatic acid.

* Translated from the "Journal de Physique," March 1806, p. 211.

is decomposed by diluting it with water, and the muriat is precipitated.

Muriatic acid forms a muriat with pure silver, and hidrogen is given out.

This acid, poured on parted silver, attacks it, converts it into a muriat, and a gas is evolved, which forces the cork out of the bottle. This gas can be no other than hidrogen. The acid, which is weakened, holds scarcely any thing in solution, for hidrosulphurated water scarcely changes its colour.

That Bergman should announce this muriat as a compound of 75 parts of silver and 25 of acid, was very excusable; but that moderns, certainly not unacquainted with the term of oxidation, should repeat this—Have they forgotten the oxigen?

Muriat of silver does not act on the crucibles.

The muriat of silver does not penetrate the crucibles, or even their surface. It does not act upon them.

Is not volatile.

I did not perceive that it was volatile. During the first impression of the heat only, and by the assistance of the moisture present, a vapour escapes, which is condensed in the empty crucible inverted over it. This sublimate, as Stahl observed, has the appearance of powdered arsenic; but when the muriat is in fusion, no more vapour escapes, and it remains fixed at the bottom of the crucible. Four drams of fused muriat were kept at a moderate red heat for half an hour in a covered Hessian crucible. The crucible, on coming out of the fire, had lost 6 grains: but it was only because a little of the muriat had made its way through one of those flaws, which frequently occur in them if the paste were not very carefully kneaded before it was applied to the wheel.

Half an ounce of the same muriat, heated the same time in a luted retort, did not attack the glass, or give the slightest indication of sublimate. Sage observed the same.

Transparent, of a pearly grey, exactly like the native muriat.

The muriat heated to this point is transparent; and has a pearly grey hue, by which it is distinguished. With this appearance it is so perfectly like the native muriat, that it is impossible not to confound them together; so true it is, that Nature has not two scales for these combinations.

Crystallizes in octahedrons.

The muriat has a decided tendency to crystallize in octahedra.

octahedra. I have a piece of four ounces, in which a horizontal matrix is formed, that is lined with these crystals. The solution of the muriat in ammonia likewise deposits regular octahedra.

The ammoniacal solution will keep several years, without the muriat's tending to decomposition: but if a separation be forced to take place, even by a moderate heat, fulminating oxide may be formed. This I learned from the following fact:—I placed a capsule containing some of the ammoniacal solution in a moderate heat, for the purpose of collecting the muriat. The liquor being evaporated to a certain point, and a few grains of precipitate having formed, I took it up by the edge, and with blameable carelessness put it into my other hand. The powder at the bottom immediately exploded, cracked the bottom of the capsule, and blew all the liquor into my face. Happily I escaped with no other mischief than the skin's remaining black for some days.

Ammoniacal solution of it keeps long, but being decomposed by a gentle heat, fulminating silver formed.

To form a clear idea of the characters of this muriat, and even to make it known in teaching others, it should be poured when half red hot into a silver basin, and moved about circularly, as you would melted nitre. You may then turn it out in a thin, transparent, flexible plate, which may be cut with scissars almost like the horn for lanterns.

Method of exhibiting it to advantage.

If you let it cool in the crucible, to have it in thicker pieces, they may be turned, and made into snuff-boxes, as Kunckel observed; which succeeds better with large pieces than small. I have plates of it of a reddish tint, and marbled like tortoiseshell; but exposure to the light makes it more and more brown, which lessens the value it would otherwise have in jewellery.

Large pieces may be turned into toys, — but the air changes their colour.

Kunckel, in his Chemical Laboratory, gives a method of reducing the muriat, which is expeditious, and not liable to much loss. Put three parts of lead, he says, with one of *luna cornea*, into a retort, and expose them to heat; the lead will be converted into muriat, and the reduced silver will subside to the bottom. The product, however, will not be reduced silver, for it will require cupellation, to separate from it a considerable portion of lead. This process is susceptible of improvement. Three parts

Kunckel's method of reducing it.

parts of lead are a great deal too much. The muriat, which I suppose to be melted, should be enclosed in a sheet of lead twice its weight; the lead having been previously reduced from acetate of lead; and subjected to cupellation. Thus 73 to 74 hundredths and a fraction will be obtained: in four operations I could not once get 75 and a fraction, which is the real quantity present; a little silver therefore is lost. I know not whether the muriat of lead which is volatilised contributes to this.

A little silver lost.

Reduction by carbonat of potash unadvisable.

Some recommend the reduction of the muriat by means of carbonat of potash. This method is troublesome, and exposes to considerable loss, on account of the swelling up, running over, and the largeness of the crucible that must be used to avoid this even with small quantities of the muriat.

Pure potash preferable.

Pure potash is preferable, since the reduction takes place without any swelling up; but for large quantities this mode is expensive.

Having had more than a pound of muriate, arising from the repeated precipitations that there is occasion to make in a laboratory, I preferred the following method of Sage.

Sage's method.

This consists in boiling the muriat in an iron pot with a few pieces of iron and some water. The separation takes place very speedily. The liquor, which is a solution of muriat of iron, is to be thrown away; fresh water added; and the mixture occasionally shaken. The silver will be obtained in powder, which requires only to be washed, and melted with a little nitre and borax, to free the silver from a little remaining oxide of iron. If you would satisfy yourself, whether the muriat be entirely decomposed, it will be sufficient to expose the powdered silver to the sun; for if any muriat still remain, the light will give it a violet hue, and gradually darken it.

To detect any muriat left undecomposed, expose it to the sun.

Excellence of this method.

To judge of the merit of this process, I made the following experiment.

In a small silver basin I treated a hundred parts of powdered muriat, well dried, with as much iron filings and a sufficient quantity of water. The operation being finished, the muriate of iron poured off, and the powder washed, I added 18 parts of mercury to collect the silver. The

The amalgama, being subjected to distillation, gave me $72\frac{1}{2}$, instead of $75\frac{1}{4}$, which ought to have been the product. I triturated the filings again with a little mercury, and obtained $2\frac{1}{2}$ more of silver, making in all 75. The loss therefore was only $\frac{1}{400}$, or four grains on the quantity I had used, which was 1600 grains of muriat.

The result shows, that with moderate quantities of muriat the reduction may be made with ease, and without any sensible loss. In the great it is still more expeditious, since all that is necessary is to place the muriat upon lead in a cupel.

The silver separated from the muriat by means of potash, though well fused, is not always secure from retaining some of it. Forging one day a mass of about eight ounces, I was surprised to see it separate into laminæ under the hammer. On examining it, I perceived some unreduced muriat between the plates. Mr. Fernandez made the same observation, as will appear at the end of this article.

The silver reduced by means of potash sometimes retains muriat.

The muriat of silver frequently occurs among the minerals of America: it accompanies the native silver; and is found disseminated among the sulphurets, carbonats, and siliceous rocks, so as to be altogether imperceptible.

Native muriats in America.

I examined an ore from the province of Caraccas, which by the application of acids yielded me only 11 marks to the hundred; but having fused it with oxide of lead, potash, and charcoal, it yielded a button, which left 19 marks in the cupel. This ore contained its riches in two states, in metal and in muriat. The silver of this ore contained likewise a 36th of gold. Its matrix was siliceous.

Analysis of one from the Caraccas.

To discover the muriat, the ore should be boiled with water, and a few filings of iron or of zinc: the muriat will thus be decomposed, and, after washing the ore, nitric acid will detect the silver. The muriatic lixivium being precipitated with a solution of silver, the portion of muriat of silver collected will be exactly equivalent to that which existed in the ore.

Mode of discovering the muriat.

Pieces of native muriat of the greatest purity are sometimes brought from Peru. I have one that weighs about ten ounces, the matrix of which is rhomboidal carbonat.

Very pure native muriat from Peru.

This

This muriat is transparent, pearly, and may be cut without splintering. Its chips assume the violet tint in a few minutes on exposure to the sun. It may be melted in a retort, without losing any of its characteristics, or diminishing in weight. If it be brought near the flame of a candle, it flows in red drops like the juice of a gooseberry, which grow white on cooling. They should be caught on a plate of glass. The artificial muriat yields likewise coloured drops when melted. The native muriat enclosed in a sheet of lead does not yield above 74 and a small fraction of silver, though it contains 75¾.

Analysis of this ore.

I decomposed a hundred parts of this muriat by means of zinc, and precipitated the solution with nitrat of silver. The product collected was a hundred parts. I had the same result twice. The solution of silver may be employed, which will remain mingled with zinc after the decomposition has taken place; but as the necessity of filtration occasions a slight loss, only 98 or 99 will be obtained. The muriat reproduced should not be weighed, till it has been thoroughly dried.

Mingled with carbonat.

The muriat is likewise found mixed with carbonat of silver in powder, exhibiting a perfectly uniform grey paste. It is very difficult to break. Rubbing it with any hard body will make the silver shine. I have one piece which consists of silver 30, carbonat of lime 32, muriat 38.

Large piece of native silver in the *Cabinet du Roi.*

As far as I can judge from appearances, it is this paste that incloses the celebrated piece of native silver preserved in the King's collection. This piece, weighing near three hundred pounds, is still loaded with part of its valuable coat. If the miner had not robbed it of the rest, it would have been much more precious to the mineralogist. It appears to have been considerable. It was cut off with a hammer and chissel. This specimen came from the mines of Quantacaia, on the borders of the Pacific Ocean.

verta kes from oxides of iron part of their oxigen at a high temperature, and

Silver is likewise among the number of metals capable of taking from iron that portion of oxigen, which raises it from the minimum to the maximum of oxidation, or which is included between 28 and 48 per cent. But for this it must be assisted by a certain degree of heat; for on

on losing this the iron in turn, or its oxide at a minimum, takes the oxigen from the silver. The following is the experiment.

gives it back to them when cold.

In a small matras heat a solution of red sulphat of iron on parted silver, a portion of the latter will be dissolved, and the sulphat will become green. Filter, add a little water with salt, separate the muriat, and the filtered liquor, or sulphat of iron, will be precipitated green by alkalis. But if, instead of separating the silver, the filtered liquor be kept, it will exhibit scales of metal, in proportion as it cools. Now this new precipitation cannot take place but by the base of the green sulphat resuming oxigen from the silver. We shall not be surprised at this result, if we recollect, that a solution of green sulphat, mixed with a solution of sulphat of silver, instantly precipitates the metal in a shining powder. I had an opportunity of observing, some time ago, that the solution of red sulphat could not be concentrated in a basin of fine silver without giving birth to similar changes.

Proof.

Carbonat of Silver.

This carbonat, obtained by means of that of potash, is of a yellowish white colour, but does not keep well, grows black on exposure to the light, and gradually parts with its oxigen; for if at the year's end very dilute nitric acid be poured on it, a portion of silver in powder will be separated.

Carbonat of silver parts with its oxigen spontaneously.

Sulphat of Silver.

If mercury be thrown into the solution of this sulphat, it decomposes it, and the result is a flat crystallization, which scarcely deviates from the level, and of course exhibits none of the pleasing phenomena of the nitrat.

Sulphat decomposed by mercury.

Tree of Diana.

Lemery recommends, to throw mercury into a nitric solution of silver considerably diluted; and he is right. In little, or in great, very beautiful and very various trees of Diana will be obtained without fail. Homberg and Beaume, with their balls of amalgama and solution, have only complicated the process, and disgusted those, who

Arbor Dianæ.

who would enjoy without so much trouble one of the most beautiful results of experimental chemistry.

Acetat of Silver.

Acetat of silver

Distilled vinegar very readily dissolves oxide of silver, and affords long white needles, easily crystallized. Heated in a retort it gives out radical vinegar, some gasses, charcoal, and pure silver. I have not examined it further.

On the Surcharge which the Muriat of Silver is capable of giving to cornets for parting, by Don Domingo Fernandez.

Assays vitiated by employing muriat of silver imperfectly reduced.

In the month of December 1794, having occasion to assay twelve pieces of gold coin, I was surprised to see the twenty-four cornets come out with a surcharge of half a grain above the fineness they ought to have had. I repeated the assays, with all possible care, and the result was still the same. To satisfy my doubts, I examined particularly the lead and the acids I had employed; but I found nothing in them that could account for a surcharge so extraordinary.

I had no other step to take, therefore, but to return to the silver; but as this metal came from a muriat reduced by means of potash and charcoal, I was far from suspecting that it could have any influence on the results; particularly as it admitted of being drawn out by the flatting mill into very thin leaves without any apparent defects. Unwilling however to announce, that these coins were half a grain above their standard, without a fresh examination, it occurred to me, to dissolve the twenty-four cornets separately in *aqua regia*. The solution was scarcely finished, when at length I discovered the cause of the phenomenon. Each of them let fall a white powder, which I collected for examination; and I had no difficulty in recognizing it to be muriat of silver. That of each of the cornets was precisely the same weight.

After this discovery I immediately examined the quality of my silver. I dissolved some in nitric acid, and the muriat separated from it instantly. Thus it is certain, that this salt is not *always* completely decomposed in reducing it with potash; and that it may incorporate with the

the metal, or even dissolve in it, so as not perceptibly to affect its ductility, since it can be flattened out without shewing any defect in the plates.

I repeated my assays, but with pure silver also obtained from the muriat, and the surcharge disappeared. This observation made me determine to dissolve the cornets, as often I should find reason to suspect an extraordinary surcharge.

On the Nitrat of Silver.

The acid that rises from a solution when evaporating it carries off some silver, however gentle the ebullition may be. The muriatic acid makes this known instantly. This result, which I have had opportunities of proving several times, cannot fail to diminish a little the confidence we might be inclined to place in assays of ores by means of nitric acid; and we know it is indispensable to boil it long enough to resolve the last portions of sulphuret of silver.

Silver carried off on evaporating its solution.

The nitrat of silver does not appear to contain water of crystallization any more than nitre. It may be kept in fusion in a retort for a considerable time, without losing more than a hundredth of its weight. On cooling it fixes in a crystalline mass of a greyish hue, called *lapis infernalis*. This nitrat, heated till it is completely decomposed, leaves 64 hundredths of pure silver; from which we may infer, that a hundred parts of silver will produce 140 of nitrat [156·25].

Nitrat contains no water of crystallization.

A hundred parts of silver take $9\frac{1}{2}$ or $9\frac{3}{4}$ of oxigen to serve as a base to the nitrat, according to a trial I formerly made, though it would not be amiss to examine the fact again.

State of oxide in the nitrat.

This nitrat then would consist of

Oxide of silver......	69 or	70
Nitric acid	31	30

Composition of nitrat of silver.

On assaying Ores of Silver.

Many authors recommend, to precipitate the solution with copper; but this must be carefully avoided, for whatever care be taken, a little silver will always remain in the liquor, as the muriatic acid will shew. An ore that yields

Silver ores best assayed in the dry way.

yields 10 per cent by fusion will not give above $8\frac{1}{2}$, 9, or thereabouts, by precipitation. The estimation deduced from the muriat of silver too being a language not understood by those, who would have the clear product of their ores set before their eyes, it is better to proceed to the assay by fusion. The following method, an imitation of the operation in the large way, and practised by Sage, appears to me preferable to any other.

The best method, as practised by Sage.

Melt a quintal of the roasted ore with as much litharge, and three quintals of common carbonat of potash, in a crucible, the bottom of which is lined with 24 or 30 grains of charcoal, softened with a little oil, so that the paste may be applied to the bottom and half way up the side by the finger. Put on a cover, but without luting it. Place two such crucibles side by side in a common furnace, and cover them with charcoal. The bellows are not necessary. When the mixtures enter into fusion, which will readily be perceived by the ear, push the charcoal aside, so that you may be able to take off the lids, and see what is going on. If the effervescence raise the contents above the middle of the crucible, remove the lids, when the weight of the air will check the swell, and prevent it from running over. As soon as all is quiet, put on the lids again, cover up the crucibles with charcoal, and let them stand till they are cold. If the assays have been well fused, the leads obtained will not differ in weight two grains. Subject them to cupellation, and you will obtain buttons, which ought not to differ a sixteenth of a grain. A sixteenth of a grain represents an ounce in a hundred pounds: but if the ore be so poor as to yield less than an ounce, as is the case with most of the mines at present worked in America, the assay should be made with four hundred grains at least.

Nitrat of Silver at a Minimum.

Preparation of minimum nitrat of silver.

In a solution already saturated boil powder of silver, such for instance as is obtained in ordinary parting; and continue the ebullition for an hour after nitrous gas has ceased to be evolved. Pour off the liquid with its sediment, and leave it to grow clear by subsidence. Draw off the clear fluid with a bulbed siphon, and, if you wish to

to concentrate it, pour it into a retort, at the bottom of which a few bits of pure silver have been previously put; if not, keep it in a bottle.

But the parted silver must be cleansed before it is used, to avoid any mixture of copper. For this purpose boil the powder in a saturated solution of silver slightly diluted, when the copper will be converted into nitrat, and the silver will come out sufficiently pure to effect no alteration in the colour of the fresh nitrat.

Parted silver should be freed from copper.

The solution is invariably of a pale yellow colour; and it may be concentrated much beyond the nitrat at a *maximum*, without fear of crystallization, as the nitrat it affords is infinitely more soluble. When it is in the proportion of 240 to 100 of water it is still far enough from crystallizing, and sometimes it remains fluid for several days: but if it be poured into a phial, it congeals so suddenly, that the last portions from the mouth of the retort become solid like icicles from the eaves of a house, and a great deal of heat is evolved.

Minimum nitrat very soluble.

Suddenly becomes solid.

While this nitrat is concentrating, a little is always volatilized. This passes from the minimum of oxidation to the maximum; and sometimes we discover in it a mixture of the two nitrats. In the first case ammonia does not change the transparency of the product; in the second, the new nitrat is indicated by a black hue.

A little volatilized and changed during evaporation.

It is difficult to bring it to a regular crystallization, because it has a much greater tendency to congeal, than to separate into crystals. If it congeal, it cannot be redissolved, without the separation of a yellow powder, which obliges us to suspend the process, that this powder may be allowed to subside, decant the clear fluid, and return it into the retort. It is true that this inconvenience may be avoided, by an addition of acid to the water with which the mass is to be redissolved; but by this addition we are liable to increase the oxidation of a portion of the nitrat, and to convert the product into a mixture of the two nitrats.

Difficult to crystallize.

Yellow powder produced,

The yellow precipitate we have just pointed out, is a nitrat doubly at a *minimum*, both of oxigen and of acid. It forms because part of the new nitrat cannot dissolve in water, unless it takes from the other a little of its acid; and

which contains a minimum both of oxigen and of acid.

and it is the loss of acid experienced by this portion, that occasions it to be precipitated. These effects are completely analogous to those of the nitrat of mercury at a *minimum* of oxidation when thrown into water. If it do not divide into two parts, and if one do not borrow acid from the other, it does not dissolve: but in the case before us, as well as in that of mercury, a little acid sets the yellow precipitates afloat, it increases their saline state, and in consequence restores their solubility.

Analogous phenomena with mercury.

We may succeed in crystallizing it, however, by successively suspending and resuming the distillation, till by repeated trials we have brought the solution to the proper point. But I have not yet been able to obtain crystals sufficiently separate, and out of the retort, to be able to examine them easily.

Mode of obtaining crystals.

Properties of this Nitrat.

Its solution kept in the air, and defended from dust, loses its colour, and in a few days affords large square laminæ of the common nitrat, or that at a *maximum*.

Attracts oxigen from the air,

It is amusing to observe the readiness with which a few drops of nitric acid, poured into this solution, give rise to large scales of nitrat. The fluid changes from white to yellow, blackens more with ammonia, and at length becomes wholly nitrat at a *maximum*. If the acid be mixed with a more dilute solution, and heated, nitrous gas is evolved, and confirms the change indicated by theory.

and from nitric acid.

Muriatic acid poured into the solution of *minimum* nitrat affords a muriat, the base of which rises to the *maximum* in the very process. There is no muriat at a *minimum* therefore; or at least I have not been able to form one. The following are some of its most striking habitudes with reagents.

Muriat of silver only in one state.

With water of litmus the solution of common nitrat of silver produces no effect; that of the *minimum* nitrat precipitates a blue lake.

Its effects on litmus,

With cochineal the *maximum* nitrat produces a scarlet colour; the *minimum*, a deep violet lake.

cochineal,

With solution of indigo in sulphuric acid the *maximum* occasions

indigo,

occasions no change; the *minimum* deprives it entirely of colour, and the silver is reduced.

The tincture of fecula of hemlock, which is of a feuillemort colour, is not changed by the *maximum* nitrat: by the *minimum* the green is revived and beautified in a striking manner. tincture of hemlock,

With Ammonia.

Ammonia precipitates the *minimum* nitrat black. The precipitate collected is pure silver, and does not fulminate, however long it be kept in the ammonia. The ammonia then holds *maximum* oxide in solution; for if it be saturated with very dilute nitric acid, it is no longer blackened by ammonia. Thus we see, that the portion of oxide dissolved in ammonia is raised to a *maximum* at the expense of that which is precipitated. ammonia,

With pure Potash.

The precipitate is brown, resembling in colour that given by the *maximum* nitrat. Redissolved in nitric acid, ammonia precipitates it black, which demonstrates that the oxide has not altered its state; but on drying it attracts oxigen from the atmosphere, rises to the *maximum*, and no longer differs from the precipitate afforded by the *maximum* nitrat. potash,

With Alcohol.

Alcohol acts on its solution no otherwise than water: part of the nitrat, its portion of acid being diminished, separates in a yellow powder. The alcoholic solution being distilled, leaves behind nitrat at a *maximum* and powder of silver, because part of the oxide has completed its oxidation at the expense of the other. The alcohol is not converted into ether in this case, any more than with the *maximum* nitrat, which it dissolves perfectly well. alcohol,

With boiling Water.

It has been seen, that cold water separates this nitrat into two parts; that one, to enable it to dissolve, was obliged to take acid from the other, which was conse- and boiling water.

quently

quently separated in the state of yellow nitrat, or nitrat with an inferior portion of acid. With boiling water the change proceeds farther.

If a few drops of a somewhat concentrated solution be let fall into a glass of boiling distilled water, three colours will be seen distinctly to succeed each other very quickly, yellow, red, and black. If, when the mixture is yellow, or red, a few drops of acid be added, the whole grows clear, and the change is stopped. If this be done the moment after the black colour has appeared, the acid no longer restores the transparency of the mixture, because the black powder is not an oxide, like the two preceding, but disoxidated silver. Now to dissolve this a stronger acid is required.

Disoxidates the silver.

The black powder silvers the glass as it comes into contact with its sides. None of these effects will take place, if a few drops of nitric acid be added, before the solution is dropped into the boiling water.

Nitrat of mercury has similar properties.

The yellow nitrat of mercury at a *minimum* exhibits similar phenomena, though in a different manner. This nitrat, boiled with water in a retort, affords powder of mercury, which passes into the receiver with the aqueous vapour; that is to say, by the help of a high temperature part of the mercury has a tendency to complete its oxidation at the expense of the other. But in whatever circumstances we discover a metal passing from one state of oxidation to another, we shall never find it stopping at any intermediate term between the two extremes of oxidatian proper to it.

Metals never found at an intermediate state of oxidation.

Attracts oxigen from the air but slowly.

An aqueous solution of *minimum* nitrat of silver does not superoxide itself very rapidly by contact with air.

Acids have more affinity for oxides of silver than of copper.

I have formerly shewn, that, if copper have a greater affinity for oxigen than silver has, we must not thence conclude, that acids would have more affinity for oxide of copper than for oxide of silver; and in fact the nitrat and sulphat of silver dissolved and kept on carbonat of copper do not attack the latter, or even become coloured. The *minimum* nitrat of silver is equally void of action on carbonat of copper.

The yellow powder, or *minimum* nitrat with less acid, is equally void of action on the carbonat of copper.

The

The *minimum* nitrat, concentrated in a retort, grows thick, gives out a little nitrous gas, enters into fusion, and affords a yellow sublimate that lines the sides of the retort. The *maximum* nitrat affords nothing similar to this. If the melted mass be dissolved, we see a yellowish precipitate, mixed with a little powder of silver, fall to the bottom; which indicates, that a part of the *minimum* nitrat remains unaltered, and that another portion has assumed the *maximum* state, by means of the oxigen attracted from part of the oxide.

Minim. nitrat fuses and sublimes.

Several years ago I remarked this transmission of oxigen from one portion of an oxide to another, in those solutions of silver in which I had carried the ebullition on metal pretty far. A kind of brilliant aventurine disturbed its transparency at the expiration of a few days, and afterwards subsided to the bottom of the vessels. This was the first fact that led me to suspect, that silver, like so many other metals, was susceptible of two determinate states of oxidation.

Nitrat of lead treated with leaves of this metal exhibits results of the same class. I will endeavour soon to lay them before the public.

Nitrat of lead affords similar results.

VI.

Description of a Machine for cutting Paper and the Edges of Books. By Mr. John J. Hawkins *.

THE object of this improvement is, to cut the edges of books on three sides at one fixing in the press: to do this, it is necessary that the book be placed at one end, and a support given to the plough beyond the part cut; there is therefore at each corner a block moveable on a centre, so as to elongate alternately the side or end of the press.

Machine for cutting the edges of books, &c.

The press is as wide as the intended length of the book.

* Communicated to the Society of Arts, who voted the Silver Medal to the inventor.

Machine for cutting the edges of books, &c.

At a distance from the end of the press, equal to the required width of the book, is a stop, made somewhat like two combs, one fastened on each side, the teeth of one going into the interstices of the other, so that it may effectually prevent the book falling too low, whether the press is open little or much.

In the common press, the book is put in the middle, and there is a screw at each end to force the press together; but in this press, the book being put at one end, there is a screw about the middle to force the press together, and another screw at the lower end to force it open, and consequently press the book tighter, exactly on the principles of cabinet-makers' hand-screws.

Reference to the Engraving, Plate IX. Fig. 1, 2, 3, 4.

Fig. 1 and 2. Two geometrical views of the press.

Fig. 3 and 4. Two perspective views of the same, as placed on its supports in the box which receives the cuttings. The side of the box is represented as taken away, in order to show the parts more distinctly. *Fig.* 3 shows the position of the press, when the front of the book is to be cut, and *Fig.* 4, while the ends are cutting.

N. B. The letters of reference are the same in all the *Figures*.

A. The press.

a. The cutting box.

b b. The elongating blocks turning on their centres (*c*).

d. The screw which forces the press together.

e. The screw which forces the lower ends of the press asunder, and consequently presses the book tighter.

f. A piece of board put into the press with the book, to keep it firm against the knife.

g. The comb-like stop.

h h. Bars fixed across the cutting box, to support the press while the top or bottom of the book is cut.

i i. Bars to support the press while the front of the book is cut. In this position, there is a bar (*k*) to keep the press steady, which is taken out when the position *Fig.* 4 is in use.

l l. Pieces

ll. Pieces of board with notches in them, fastened to the box, to receive the bars.

Machine for cutting the edges of books, &c.

m. Groove for the plough to work in.

It is evident from the positions of the press, that the plough must be worked on an inclined plane; but this, instead of an objection, is a considerable advantage, because the workman has much more power in that direction, than on a level.

The press requiring to be turned round to cut the top and bottom of the book, the plough must be worked left as well as right handed, but this is acquired by a few minutes practice.

The same plough is used as with the common press.

J. J. HAWKINS.

Dalby Terrace, City Road,
May 29, 1805.

CHARLES TAYLOR, Esq.

VII.

Observations on the Permanency of the Variation of the Compass at Jamaica. In a Letter from Mr. JAMES ROBERTSON *to the Right Hon. Sir* JOSEPH BANKS, *K.B. P. R. S. &c*.*

SIR,

General introduction.

AS any improvement, or discovery in the arts and sciences, will, I am persuaded, experience your favourable reception, I have the honour of submitting to your consideration a discovery I have made on a subject, the state of which can only be ascertained by observations made from time to time, as it is not regulated by any known law of Nature; I mean the variation of the magnetical needle.

This discovery may not only excite others to make, and repeat, observations in different parts of the globe, but, by causing this changeable quality to be better understood, may contribute to the benefit of navigation, and

* Phil. Trans. 1806.

commerce, as well as to the advancement of a more particular knowledge of the subject.

The magnetical variation is universally supposed to change in the course of time. Exc-ption.

It has hitherto been considered, that the variation of the magnetical needle is not fixed in any particular place, but is constantly varying, in a greater or a less degree, in all parts of the world. I have discovered an exception to this supposed general property of variation; and, as it may be, perhaps, the first that has been made, it will require proportionally strong proof to establish it. This, I flatter myself, I am able to effect, to the certainty of demonstration itself; but, in doing so, I am under the necessity of being more tedious than I could wish, in order to describe fully the data, on which the inference is founded.

Lands in Jamaica are held under grants with a diagram annexed

I resided at Jamaica, as a King's Surveyor of Land, upwards of twenty years. Disputes at law about boundaries of lands are there decided by ejectments, in the Supreme Court of Judicature, by the evidence and diagrams of King's Surveyors of Land. This is different from the practice in England, because the manner in which grants of land from the Crown are made, in the two countries is different. In Jamaica, to every grant of land a diagram thereof is annexed to the patent. This diagram is delineated from an actual survey of the land to be granted, having a meridional line, according to the magnetical needle, by which the survey was made, laid down in it. No notice is taken of the true meridian. The boundary lines of the land granted are marked on earth, (as it is denominated,) by cutting notches on the trees between which the line is run through the woods.

— referring to permanent lines of the estate, determined at first by compass.

These trees being mostly of hard timber, the notches will be discernible for thirty years, or more. By repeated re-surveys these lines are kept up; and, when the cultivation, on both sides, renders it necessary to fell the marked trees, (which can only be done by mutual consent, it being otherwise death by the law,) logwood fences are planted in the lines dividing the properties thus cultivated; and many of these fences have been regularly repaired, and kept up, to the present time. Lands were granted from the Crown soon after the Restoration, in 1660; and every succeeding year the number of patents

increased.

increased. The old estates have been often re-surveyed, and plans of them made, and usually annexed to deeds of conveyance, or mortgage, which must be enrolled, within a limited time, in the office of the Secretary of the Island! where, also, all the patents, and diagrams annexed to them, are recorded. In all disputes at law about boundary lines, where the keeping up of the old marked lines on earth has been neglected, surveyors are appointed to make actual re-surveys of all the old marked lines on earth, (preserved in the manner before mentioned,) and to extract from the Secretary of the Island's office correct copies of all such diagrams annexed to patents, and to deeds of conveyance, or mortgage, of lands in the neighbourhood where the disputed boundary is, as they may think necessary for the investigation thereof. They then compare the lines, and meridians, of these original diagrams with those in their diagrams delineated from their own re-surveys recently made; when it is always expected that the lines, and meridians, of the former will coincide with those of the latter. It is evident that this coincidence could not happen if any variation of the magnetical needle had taken place in the intermediate time elapsed between the making of the first and of the last survey. My business being very extensive, I was frequently applied to in disputes at law about boundary lines, and I had, besides, abundance of opportunities, on other surveys, to ascertain this fact satisfactorily. From all which I have discovered that the courses of the lines, and meridians, delineated on the original diagrams annexed to patents, from 1660, downwards to the present time, and of the re-survey diagrams thereof, annexed to deeds, coincide with, and are parallel to, the lines and meridians delineated on the new diagrams from recent surveys made by the magnetical needle, of the same original marked lines on earth, (preserved as before described); so that whatever course is laid down for the line on the diagram annexed to the patent, (and let it be supposed, for example, to be north and south, or east and west,) upon setting the compass in the old marked line on earth, and directing the sights north and south, or east and west, according to the magnetical needle, the said

The compass at Jamaica shews the same bearings— — on the ground as were determined 130 or 140 years ago.

said marked line on earth, originally run by the magnetical needle 130 or 140 years ago, has been found by me to be exactly in the line, or direction with that of the compass; consequently no alteration of the variation could have taken place during the whole, or any part, of that period of time in Jamaica.

Qu. Whether the variation was allowed in ancient times?

To this it may not be unacceptable to subjoin a short history of the practice of surveying in Jamaica, from the Restoration to the present time, in order to obviate any doubt that might arise, whether there be not a possibility of the quantity of the magnetical variation having been ascertained, and allowed for, in the first diagrams annexed to patents: and whether the variation of $6\frac{1}{2}$ degrees east, which corresponds with the magnetical needle now, might not then, have agreed with the true meridian.

The variation first noticed by Columbus,

The variation of the compass was first observed by Columbus, in his first voyage across the Atlantic, in the year 1492; and seemed to threaten that the laws of Nature were altered in an unknown ocean. It is evident, however, that Columbus was not able to ascertain the quantity of variation; for if he had ascertained it, the danger he was in would have been diminished, if not entirely removed. His discovery, therefore, must have been simply the deflection of the magnetical needle from the true meridian, without knowing the quantity thereof.

— and systematized by Halley, who in 1700 found the same variation at Jamaica as now.

From this period down to the year 1700, when Dr. Halley published his "Theory of the Variation of the Compass," no observations, ascertaining the quantity of variation, in the West Indies, were, I believe, published. He was the first that made any in South America, and these were chiefly applicable to the coast of Brasil. With his theory was published "A new and correct Chart of "the whole World, shewing the Variations of the Com-"pass, &c. as they were found in 1700, by Direction of "Capt. Edm. Halley." By this chart the variation, at Jamaica, appears to have been the same as it is at present. His theory could have been known but to few; nor do any observations, in the West Indies, appear to have been made for many years after its publication. Indeed I know of none till very lately, and these only in a few charts. But, however extensive its publicity might have

been,

been, it could have had no influence in directing the surveys, in Jamaica, that preceded it by 30 or 40 years.

The ascertaining of the true meridian, and, consequently, of the magnetical variation from it, requires more scientifical, as well as practical, knowledge, than is often to be met with even at this time; but, 130 or 140 years back, it was entirely confined to a very few individuals. The magnetical needle was then the only guide and rule to go by, both at sea and at land, and, generally, without any reference being had to the true meridian.

The early surveyors were guided only by the compass—

Had the first surveyors ascertained the quantity of variation, and allowed for it, in delineating their diagrams that were annexed to the earliest patents in Jamaica, they would have mentioned the same in such diagrams; otherwise it could only tend to mislead, not to direct. The same system of surveying would, and must, by law, have been continued; for, (as was stated above,) the number of grants has been annually increased; and the uninterrupted practice of surveying, which was always daily increasing in proportion to the extending cultivation and settlement of the island, could not admit of any change, without a new law having been made by the legislature for that purpose; and then such a change must have been recorded with the laws of the island, and with those that regulated the conduct of surveyors. No surveyor, nor other person, could have been ignorant of such a change having taken place. Since even the difference of one degree in running a line is very considerable; but that of six would have totally changed all property, deranged all boundaries, thrown woodlands into plantations, and *vice versâ*: and, consequently, would have been so palpable and injurious as to have demanded legislative interference and correction. But no such change has ever happened, nor has the most remote idea of it ever been entertained. On the contrary, the magnetical meridian, in all disputes at law about boundary lines, is, and always has been, the only criterion by which the surveyors, the court, and the jury, decide.

—and certainly allowed nothing for variation in their drafts.

If it had afterwards changed the legislature must have noticed it.

From the year 1700, when Dr. Halley's theory was published, it is very easy to trace down the practice of surveying in Jamaica, as well as up to its commencement. When

The early field books and documents of surveys have

been preserved.

When I arrived in that island, upwards of twenty-five years since, I became acquainted with the oldest surveyors there, who had practised from thirty to forty years. They had the original papers, field notes, and diagrams of their predecessors, up to the dates of the first surveys. Many of these original papers, field notes, and diagrams are now in my possession; from which the practice of surveying, taking field notes, and delineating them on diagrams, is clearly shown.

The original division of Jamaica into counties and parishes was made by compass, and the compass still agrees with it.

Jamaica was early divided into counties and parishes, the boundary lines whereof were defined by the legislature, and the lines of many marked on earth. In the county of Surrey, the line, dividing the parishes of Portland and St. George, is a north and south line, by law, and was marked on earth according to the magnetical needle. It continues in the same direction. In the county of Cornwall, the dividing line between the parishes of St. James and Trelawney continues a north and south line, on earth, as it was first run by the magnetical needle. This will be evident on the inspection of my maps of Jamaica, lately published. It became necessary, in giving the island its true position on the globe, to ascertain its latitude and longitude; and also the true meridian, with the quantity of the variation of the magnetical meridian from it. But I have applied these meridians differently in the maps of the counties, and in that of the island. In the former, in which the situation on the globe is not given, the magnetical is laid down as the principal meridian; because all surveys of every other description, as well as those of the boundary lines of counties and parishes, are regulated by it; and the true meridian is introduced only to shew the variation; but, in the latter, in which its place on the globe is fixed, as to latitude and longitude, the true meridian becomes the principal one; and the magnetical meridian shows the quantity of variation from it, and regulates the surveys, and the relative situation of places, as in the county maps.

The surveys under Sir Henry Moore, in

When Sir Henry Moore, (who was considered a great surveyor,) was governor of Jamaica, about the year 1760, maps of that island were constructed, under his imme-

diate

diate direction, by Mr. CRASKELL, the island engineer, and Mr. Simpson, both eminent surveyors. But, in these maps, the magnetical meridian only is represented. Neither the magnetical variation nor the true meridian is mentioned: the island's place on the globe, as to latitude and longitude, is not given. In short, the true meridian has never been noticed, nor the quantity of variation ascertained, nor the variation even mentioned, nor the latitude and longitude, observed by any *surveyor* or *engineer* in Jamaica, but myself.

1760, were made without notice of the variation.

Although the discovery of the variation's not varying, in Jamaica, is established on the clearest evidence without the aid of other data, yet it is highly gratifying to find Dr. Halley, as it were, confirming it to the minutest accuracy, as will appear from the recital of the following observations of Mr. Long, in his History of Jamaica.

"The variations of the magnetical needle were observed by Dr. Halley to be very small, near the equator. I have seen no account of them for this island, that can be relied upon; but, if observations should be faithfully made here, they would probably confirm his opinion. According to Mountain's chart, constructed in the year 1700, from Dr. Halley's tables, the variation at Port Royal then was about $6\frac{1}{2}$ degrees east. But, as in most parts of the world it is found to be continually either increasing or decreasing, so we may reasonably conclude, that it may have altered in both respects very much during this long interval that has passed since the construction of the chart."

Quotation shewing the variation in 1700 to have been 6 deg. and a half east—

The magnetical variation, ascertained by me, and laid down in my maps of Jamaica, is $6\frac{1}{2}$ degrees east.

—and it is the same now (1806).

I leave to others, better qualified than I am, to inquire and to point out, what improvements natural philosophy may derive from this discovery; which I hope may be an acquisition to science.

I am afraid I have been too prolix. But the importance of the subject, and my desire to remove even the shadow of any doubt that might be suggested, will, I trust, be admitted as my apology.

I have the honour to be, &c.

JAMES ROBERTSON.

VIII.

Observations and Remarks on the Figure, the Climate, and the Atmosphere of Saturn, and its Ring. By WILLIAM HERSCHEL, *LL. D. F.R.S**.

Changes in the appearance of Saturn—

MY last year's observations on the singular figure of Saturn having drawn the attention of astronomers to this subject, it may be easily supposed that a farther investigation of it will be necessary. We see this planet in the course of its revolution round the sun in so many various aspects, that the change occasioned by the different situations in which it is viewed, as far as relates to the ring, has long ago been noticed; and Huygens has given us a very full explanation of the cause of these changes †.

— affect the body of the planet as well as the ring.

As the axis of the planet's equator, as well as that of the ring, keeps its parallelism during the time of its revolution about the sun, it follows that the same change of situation, by which the ring is affected, must also produce similar alterations in the appearance of the planet; but since the shape of Saturn, though not strictly spherical, is very different from that of the ring, the changes occasioned by its different aspects will be so minute that only they can expect to perceive them who have been in the habit of seeing very small objects, and are furnished with instruments that will show them distinctly, with a very high and luminous magnifying power.

Jupiter is not so affected, because its equator is nearly in the ecliptic.

If the equator of the planet Jupiter were inclined to the ecliptic like that of Saturn, I have no doubt but that we should see a considerable change in its figure during the time of a synodical revolution; notwithstanding the spheroidical figure occasioned by the rotation on its axis has not the extended flattening of the polar regions that I have remarked in Saturn. But since not only the position of the Saturnian equator is such that it brings on a periodical change in its aspect, amounting to more than

* Philos. Trans. 1806.

† See *Systema Saturnium*, page 55, where the changes of the ring are represented by a plate.

62 degrees

62 degrees in the course of each revolution, but that moreover in the shape of this planet there is an additional deviation from the usual spheroidical figure arising from the attraction of the ring, we may reasonably expect that our present telescopes will enable us to observe a visible alteration in its appearance, especially as our attention is now drawn to this circumstance.

In the year 1789 I ascertained the proportion of the equatorial to the polar diameter of Saturn to be 22,81 to 20,61 *, and in this measure was undoubtedly included the effect of the ring on the figure of the planet, though its influence had not been investigated by direct observation. The rotation of the planet was determined afterwards by changes observed in the configuration of the belts, and proper figures to represent the different situation of the spots in these belts were delineated †. In drawing them it was understood that the shape of the planet was not the subject of my consideration, and that consequently a circular disk, which may be described without trouble, would be sufficient to show the configurations of the changeable belts. Equatorial and polar diam. of Saturn, &c.

Those who compare these figures, and others I have occasionally given, in which the particular shape of the body of the planet was not intended to be represented, with the figure which is contained in my last paper, of which the sole purpose was to express that figure, and wonder at the great difference, have probably not read the measures I have given of the equatorial and polar diameters of this planet; and as it may be some satisfaction to compare the appearance of Saturn in 1789 with the critical examination of it in 1805, I have now drawn them from the two papers which treat of the subject; Fig. 3. Plate I. represents the spheroidical form of the planet as observed in 1789, at which time the singularity of the shape since discovered was unknown; and Fig. 4. represents the same as it appeared the 5th of May 1805. The equatorial and polar diameters that were established in 1789 are strictly preserved in both figures, and the last differs from the first only in having the flattening at the Figure of Saturn.

* Phil. Trans. for 1790, p. 17. † Ibid. for 1792, p. 22.

 poles

poles a little more extended on both sides toward the equatorial parts. It is in consequence of the increase of the length of this flattening, or from some other cause, that a somewhat greater curvature in the latitudes of 40 or 45 degrees north and south has taken place; and as these differences are very minute, it will not appear extraordinary that they should have been overlooked in 1789, when my attention was entirely taken up with an examination of the two principal diameters of the planet.

On magnifying powers, particularly low powers.

The use of various magnifying powers in observing minute objects is not generally understood. A low power, such as 200 or 160, with which I have seen the figure of Saturn, is not sufficient to show it to one who has not already seen it perfectly well with an adequate high power; an observer, therefore, who has not an instrument that will bear a very distinct magnifying power of 500, ought not to expect to see the outlines of Saturn so sharp and well defined as to have a right conception of its figure. The quintuple belt is generally a very good criterion: for if that cannot be seen, the telescope is not sufficient for the purpose; but when we have entirely convinced ourselves of the reality of the phenomena I have pointed out, we may then gradually lower the power, in order to be assured that the great curvature of the eye-glasses giving these high powers, has not occasioned any deceptions in the figure to be investigated, and this was the only reason why I mentioned that I had also seen the remarkable figure of Saturn with low powers.

The figure of Saturn was not affected by gibbosity.

In very critical cases it becomes necessary to calculate every cause of an appearance that falls under the province of mathematical investigation. For this reason I have always looked upon an astronomical observation without a date as imperfect, and the journal-method of communicating them is undoubtedly what ought to be used. For instance, when it is known that my last year's most decisive observation, relating to the singular figure of Saturn, was made the 5th of May, astronomers may then calculate by this date the place of Saturn and of the earth; their distances from each other, and the angle of illumination of the Saturnian disk; by these means

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we find the gibbosity of the planet in the given situation, and ascertain that the defalcation of light could not then amount to the one-hundredth part of a second of a degree, and that consequently no error could arise from that cause.

I have divided the following observations into two heads, one relating entirely to the figure of the body of Saturn, the other concerning the physical condition or climate and atmosphere of the planet.

Observations of the Figure of Saturn.

Observations on the figure of the planet. Suspicion in 1788 that Saturn is not spheroidal.

In the collection of my observations on the planet Saturn, I have met with one made eighteen years ago, which is perfectly applicable to the present subject, and is as follows:

August 2, 1788, 21^h $58'$. 20-feet reflector, power 300. Admitting the equatorial diameter of Saturn to lie in the direction of the ring, the planet is evidently flattened at the poles. I have often before, and again this evening, supposed the shape of Saturn not to be spheroidical, (like that of Mars and Jupiter,) but much flattened at the poles, and also a very little flattened at the equator, but this wants more exact observations.

Observations shewing the apparent figure of Saturn and the variations it is subject to.

April 16, 1806. I examined the figure of the body of Saturn with the 7 and 10-feet telescopes, but they acted very indifferently, and, were I to judge by present appearances, I should suppose the planet to have undergone a considerable change; should this be the case, it will then be necessary to trace out the cause of such alterations.

April 19. 10-feet, power 300. The polar regions are much flattened. The figure of the planet differs a little from what it appeared last year. This may be owing to the increased opening of the ring, which in four places obstructs now the view of the curvature in a higher latitude than it did last year. The equatorial regions on the contrary are more exposed to view than they have been for some time past.

May 2. 10-feet, power 375. The polar regions are much flatter than the equatorial; the latter being more disengaged from the ring appear rather more curved than last

Observations shewing the apparent figure of Saturn and the variations it is subject to.

last year, so that the figure of the planet seems to have undergone some small alteration, which may be easily accounted for from our viewing it now in a different aspect.

The planet Jupiter not being visible, we cannot compare the figure of Saturn with it; but from memory I am quite certain that the flattening of the Saturnian polar regions is considerably more extended than those of Jupiter.

May 4. 10-feet, power 527. The equatorial region of Saturn appears to be a little more elevated than last year. This part of the Saturnian figure could not be examined so well then as it may at present, the ring interfering with our view of it in four places, which are now visible.

The flattening on both sides of the pole is continued to a greater extent than in a figure merely spheroidical, such as that of Jupiter; and this makes the planet more curved in high latitudes.

The planet being in the meridian, the equatorial shape of Saturn appears a little more curved than last year; but the air is not sufficiently pure to bear high powers well.

May 5. 10-feet, power 527. The air is very favourable, and I see the planet well with this power; its figure is very little different from what it was last year.

The polar regions are more extendedly flat than I suppose they would have been if the planet had received its form only from the effect of the centrifugal force arising from its rotatory motion.

The equatorial region is a little more elevated than it appeared last year.

The diameter which intersects the equator in an angle of about 40 or 45 degrees is apparently a little longer than the equatorial, and the curvature is greatest in that latitude.

The planet being in the meridian and the night beautiful, I have had a complete view of its figure. It has undergone no change since last year, except what arises from its different situation, and a greater opening of the ring.

May

May 9. Power 527. The air being very clear, I see the figure of Saturn nearly the same as last year; the flattening at the poles appears at present somewhat less; the equatorial and other regions are still the same.

Observations shewing the apparent figure of Saturn and the variations it is subject to.

May 15, 10h 30′. I examined the appearance of Saturn, and compared it with the engraving representing its figure in last year's volume of the Phil. Trans. The outlines and all the other features of this engraving are far more distinct than we can ever see them in the telescope at one view; but it is the very intention of a copper-plate to collect together all that has been successfully discovered by repeated and occasional perfect glimpses, and to represent it united and distinctly to our inspection. Indeed by looking at the drawings contained in books of astronomy this will be found to be the case with them all*.

The equatorial diameter of my last year's figure is however a very little too short; it should have been to the polar diameter as 35,41 to 32, which is the proportion that was ascertained in 1789, from which I have hitherto found no reason to depart.

The following particulars remain as my last year's observations have established them.

The flattening at the poles of Saturn is more extensive than it is on the planet Jupiter. The curvature in high latitudes is also greater than on that planet. At the equator, on the contrary, the curvature is rather less than it is on Jupiter.

Upon the whole, therefore, the shape of the globe of Saturn is not such as a rotatory motion alone could have given it.

I see the quintuple belt, the division of the ring, a very narrow shadow of the ring across the body, and another broader shadow of the body upon the following part of the ring; and unless all these particulars are very distinctly visible we cannot expect that our instrument

* For an instance of this, see TOBIÆ MAYERI *Opera inedita. Appendix Observationum. Ad Tabulam Selenographicam Animadversiones*, where the annexed accurate and valuable plate represents the moon such as it never can be seen in a telescope.

should

Observations shewing the apparent figure of Saturn and the variations it is subject to.

should show the outlines of the planet sufficiently well to perceive its peculiar formation.

May 16, 10h 10′. The greatest curvature on the disk of Saturn seems to be in a latitude of about 40 degrees.

May 18. The difference between the equatorial and polar diameters appears to be a little less than the measures taken September 14, 1789, give it; but as the eye was then in the plane of the equator, and is now about 16 degrees elevated above it, we cannot expect to see it quite so much flattened at present.

June 3. The shadow of the ring falls upon the body of the planet southwards of the ring, toward the limb; it grows a little broader at both ends where it is upon the turn round the globe.

June 5. The planet Jupiter is not sufficiently high for distinct vision, and Saturn is already too low to use a proper magnifying power; but nevertheless the difference in the formation of the two planets is evident. The equatorial as well as polar regions on Jupiter are more curved than those of Saturn.

June 9. The air is beautifully clear, and proper for critical observations.

The breadth of the ring is to the space between the ring and the body of Saturn as about 5 to 4. See Fig. 3.

The ring appears to be sloping toward the body of the planet, and the inside edge of it is probably of a spherical or perhaps hyperbolical form.

The shadow of the ring on the planet is broader on both sides than in the middle; this is partly a consequence of the curvature of the ring which in the middle of its passage across the body hides more of the shadow in that place than at the sides.

The shadow of the body upon the ring is a little broader at the north than the south, so as not to be parallel with the outline of the body; nor is it so broad at the north as to become square with the direction of the ring.

The most northern dusky belt comes northwards on both sides as far as the middle of the breadth of the ring where it passes behind the body. It is curved toward the south in the middle.

I viewed

I viewed Jupiter, and compared its figure with that of Saturn. An evident difference in the formation of the two planets is visible. To distinguish the figure of Jupiter properly it may be called an ellipsoid, and that of Saturn a spheroid.

Observations on the periodical Changes of the Colour of the polar Regions of Saturn.

In the observations I have given on the planet Mars, it has been shown that an alternate periodical change takes place in the extent and brightness of the north and south polar spots *; and I have there suggested an idea that the cause of the brightness might be a vivid reflection of light from frozen regions, and that the reduction of the spots might be ascribed to their being exposed to the sun.

Probability that the polar regions of Saturn are frozen.

The following observations, I believe, will either lead us to similar conclusions with respect to the appearance of the polar regions of Saturn, or will at least draw the attention of future observers to a farther investigation of the subject.

With high magnifying powers, the objects we observe require more light than when the power is lower; this affords us a good method of determining the relative brightness of the different parts of a planet. The less bright object will be found deficient in illumination when the power exceeds what it will bear with ease. I have availed myself of this assistance in the observations that follow.

Useful application of high powers to determine the relative brightness of objects.

June 25, 1781. With an aperture of 6,3 inches I used a magnifying power of 460. This gave a kind of yellowish colour to the planet Saturn, while the ring still retained its full white illumination.

Observations on the appearance of Saturn and its ring, partial changes of brightness, &c.

November 11, 1793. From the quintuple belt toward the south pole the whole distance is of a pale whitish colour; less bright than the white belts, and much less bright than the ring.

This has been represented in a figure which was given in the volume of the Phil. Trans. for 1794, page 32. It is

* Phil. Trans. for 1784, page 260.

is to be noticed that the south pole of the planet had been long exposed to the influence of the sun, and the former polar whitishness was no longer to be seen.

Jan. 1, 1794. The south polar regions are a little less bright than the equatorial belt.

Nov. 5, 1796. The space between the quintuple belt and the northern part of the ring is of a bright white colour.

This seems to indicate that the whiteness of the northern hemisphere of Saturn increases when there is less illumination from the sun.

May 6, 1806. The north pole of Saturn being now exposed to the sun, its regions have lost much of their brightness; the space about the south pole has regained its former colour, and is brighter and whiter than the equatorial parts.

May 15. The south polar regions of Saturn are white; those of the north retain also some whitishness still.

May 18. With a magnifying power of 527, the south polar regions remain very white. The equatorial parts become of a yellowish tinge, and about the north pole there is still a faint dusky white colour to be seen.

June 3. The south polar regions are considerably brighter than those of the north.

These observations contrasted with those which were made when the south pole was in view complete nearly half a Saturnian year, and the gradual change of the colour of the polar regions seems to be in a great measure ascertained. Should this be still more confirmed, there will then be some foundation for admitting these changes to be the consequence of an alteration of the temperature in the Saturnian climates. And if we do not ascribe the whiteness of the poles in their winter seasons immediately to frost or snow, we may at least attribute the different appearance to the greater suspension of vapours in clouds, which, it is well known, reflect more light than a clear atmosphere, through which the opaque body of the planet is more visible. The regularity of the alternate changes at the poles ought however to be observed for at least two or three of the Satnrnian years, and this, on account of their extraordinary length, can

The changes correspond with winter and summer on the planet.

only

only be expected from the successive attention of astronomers.

On the Atmosphere of Saturn.

June 9, 1806. The brightness which remains on the north polar regions, is not uniform, but is here and there tinged with large dusky looking spaces of a cloudy atmospheric appearance. Atmosphere of Saturn and of its ring.

From this and the foregoing observations on the change of the colour at the polar regions of Saturn arising most probably from a periodical alteration of temperature, we may infer thee existence of a Saturnian atmosphere; as certainly we cannot ascribe such frequent changes to alterations of the surface of the planet itself; and if we add to this consideration the changes I have observed in the appearance of the belts, or even the belts themselves, we can hardly require a greater confirmation of the existence of such an atmosphere.

A probability that the ring of Saturn has also its atmosphere has already been pointed out in a former Paper.

Slough, near Windsor,

June 12, 1806.

SCIENTIFIC NEWS.

A Report of the Transactions of the Class of Mathematical and Physical Sciences of the National Institute of France, for the preceding Year, was made at the public Meeting of the 7th of July last, of which the following is an abridgment.

(Concluded from p. 337.)

Geographical researches.

TO these geometrical considerations respecting the figure of the earth the reporter observes, that the order of connection would naturally direct him to the geographical researches on the extensive plain of the interior of Africa, by Lacepede; upon Persia, and the communication between the Caspian and the Black Seas, by Olivier; but as these memoirs more particularly belong to physical science, and as such have been analized by Cuivier, he passes to the consideration of M. Raymond's memoir upon the Admeasurement of the Heights of Mountains by means of the Barometer.

Measure of heights of mountains by the barometer.

It was remarked in the Report of 1805, that there was scarcely one five-hundredth part of difference between the coefficient of La Place for calculating the heights of mountains by barometrical observation and that which M. Raymond has deduced from numerous observations of this kind made in the Pyrennees. New researches have entirely obliterated a difference which might be attributed either to the barometrical observations or to the earlier experiments on the respective weights of air and mercury which M. La Place had used in his computations. M. Biot has lately repeated these experiments with the utmost precaution; from whence it results that the coefficient must be diminished very nearly one five-hundredth, and the methods perfectly agree together.

On

On the one hand we observe the geometer assuming as data the facts observed in the cabinet of an experimental philosopher deduces a rule for measuring the heights of mountains; and on the other, an observer assuming for his basis of deduction the known height of a mountain, and the effect which it produces upon the elevation of the mercurial column in the barometer, draws his conclusion as to the relative weights of mercury and of air, and finds the same quantities which were made use of by the geometer for establishing his calculations. These comparisons, which become every day more numerous in the application of analysis; these identical results obtained by processes so contrary, and deduced from phenomena so different, are proofs which establish the sciences beyond all question.

Circumstances necessary to be attended to in barometrical observations.

This important result does not constitute the only merit of M. Raymond's memoir. Methods of distinguishing the circumstances most favourable or most inimical to this description of observations, are pointed out and arranged under three different titles,—The influence of the time of day, of the stations, and of the meteors. As to the time of day, it is found that the heights observed in the morning and the evening are always too small; whence it follows that observations ought always to be made about the middle of the day, which is a condition very easy to be complied with. The influence of stations is not less real, but more difficult to be obviated. The rule to be followed is, that the portable barometer and the barometer of comparison should be as nearly as possible in stations where the local circumstances are the same. A great distance or interval is not always an obstacle; so that M. Raymond has remarked that observations made by him on the Pyrenean Mountains, when compared with those which M. Bouvard continually makes at the Imperial Observatory, present a course of changes of considerable regularity, whereas the same observations of M. Bouvard, compared with those which M. Raymond made at Marli la Ville, indicate from one day to another, differences of ten or twelve metres or yards in the relative height of the two stations: whence it may be concluded, that the use of the barometer to measure

measure heights not much differing from each other has not much certainty when the two stations are on a plane.

With regard to the influence of meteors, it always acts in the same direction, and causes the heights to appear too small; whence all observations are to be rejected which were made in stormy weather. From all these considerations it follows that in order to have the most exact height of a mountain it will not be proper to take a mean indifferently between all the observations made at different hours and seasons, as in this case the elevation would always prove less than the truth.

Various researches, discoveries, &c.

An extensive course of experiments by M.M. Biot and Arago upon the affinities between the different gases and light are not spoken of by the reporter, because M. Biot purposes to give an extract himself. An abridgment of Count Rumford's memoir on the dispersion of the light of lamps through ground glass, likewise composes part of the present report, which need not be given in this place, because the Count's memoir has already appeared in our Journal.

Simple notices of inventions in Science and the Arts which are entitled to honourable mention, are likewise given in the present report, but as they contain no accounts of the methods or processes, it has not been thought necessary to repeat them here. Since its last public sitting the Class has published the first volume of Memoirs presented by learned Foreigners (Savans Etrangers), and the sixth volume of its own Memoirs. The following volumes will be published every six months, beginning with July last. The first volume of La Méridienne de Dunkerque, base du Système Mêtrique décimal. This work contains all the authorities, observations, and methods of calculation which have fixed the two fundamental unities of the Metrical System, namely, the Metre and the Kilogramme.

Various publications.

Several members have published new works, or new editions of works already known, in which important additions are found. Among these M. Legendre has published a sixth edition of his Geometry, and Lacroix a

second

second edition of his Elementary Treatise on the differential and integral Calculus. Various publications.

The astronomical world is now in possession of Solar Tables, in the computation of which the attractions of all the planets have, for the first time, been admitted.

Lastly, Le Grange has given a more complete edition of his Calcul des Fonctions, a truly classical work, which requires no recommendation to those mathematicians who have perused it, and could with no degree of facility be properly announced to those who have not. La Place has also published a Dissertation, forming a supplement to the tenth book of his Mecanique Celeste, in which he gives a complete theory of the capillary action of which some notice has before been taken in our Journal. These delicate researches will not be considered merely as trials of skill by those who are aware how extensively the phenomena of Nature are connected with each other. Every variable qnantity among natural appearances becomes the measure for determining other results as soon as the law of its variation is ascertained. One object of utility is pointed out by La Place with respect to measuring heights by the barometer, in which a question has arisen, Whether the length of the mercurial column should be determined from the base or the summit of its convexity. Our author shews, that the latter is much the most correct, though this height is less than would be produced by the atmospheric pressure if the capillary repulsion did not act. He gives two methods of correction.

Philosophical Transactions of the Royal Society of London for the Year 1806, Part II. 4to. 454 pages, with 12 Plates. London. Nicol. Royal Society.

This part contains the following articles: 1. Observations upon the Marine Barometer, made during the examination of the Coasts of New Holland and New South Wales, in the Years 1801, 1802, and 1803. By Matthew Flinders, Esq. Commander of his Majesty's ship Investigator. 2. Account of a Discovery of native Minium. By James Smithson, Esq. F.R.S. 3. Description of a rare Species of Worm Shells discovered at an Island lying off the North-west Coast of the Island of Sumatra, in the East Indies. By J. Griffiths, Esq.

4. Observations

Various publications.

4. Observations on the Shell of the Sea Worm found on the Coast of Sumatra, proving it to belong to a Species of Teredo; with an Anatomy of the Teredo Navalis. By Everard Home, Esq. F. R. S. 5. On the inverted Action of the alburnous Vessels of Trees. By A. Knight, Esq. F.R.S. 6. A new Demonstration of the Binomial Theorem, when the Exponent is a positive or negative Fraction. By the Rev. Abram Robertson, A.M. F.R.S. Savilian Professor of Geometry in the University of Oxford. 7. New Method of computing Logarithms. By Thomas Manning, Esq. 8. Description of the mineral Bason in the Counties of Monmouth, Glamorgan, Brecon, Carmarthen, and Pembroke. By Mr. Edward Martin. 9. Observations on the Permanency of the Variation of the Compass at Jamaica. By Mr. James Robertson. 10. Observations on the Camel's Stomach, respecting the Water it contains, and the Reservoirs in which that Fluid is enclosed, &c. By Everard Home, Esq. F.R.S. 11. Observations on the Variation and on the Dip of the Magnetic Needle between 1786 and 1805 inclusive. By Mr. George Gilpin. 12. On the Declinations of some of the principal fixed Stars, with a Description of an Astronomical Circle, and some Remarks on the Construction of circular Instruments. By John Pond, Esq. 12. Observations and Remarks on the Figure, the Climate, and the Atmosphere of Saturn and its Ring. By William Herschell, LL. D. F.R.S. &c.

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Mr. H. Ward's new striking Movement in a Clock.

Fig. 5.

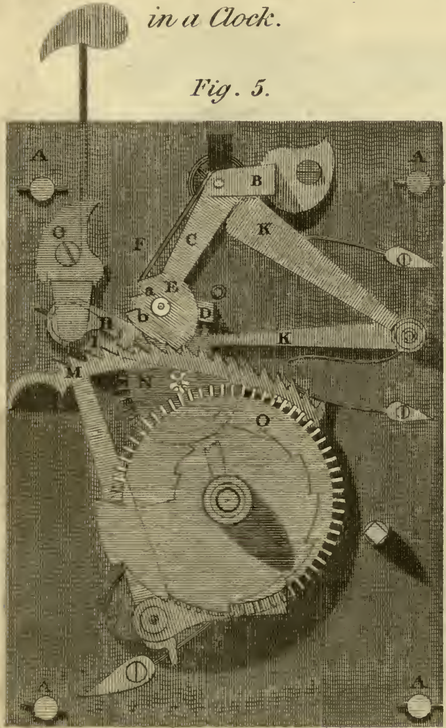


Fig. 2.

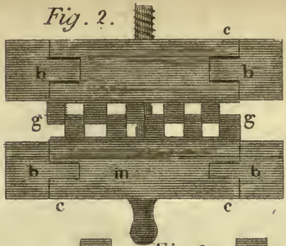
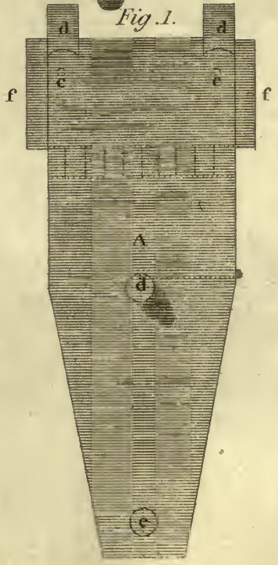


Fig. 1.



Mr. Hawkins Machine for cutting the the Edges of Books.

Fig. 3.

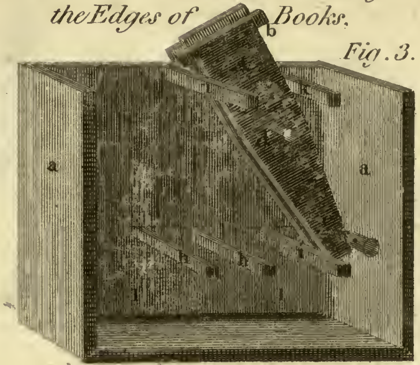
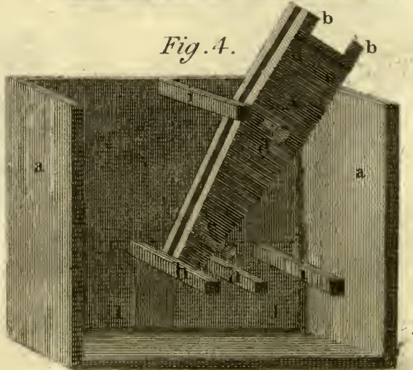


Fig. 4.



Mr. Salmon's Improvement on Canal Locks.

Fig. 1.

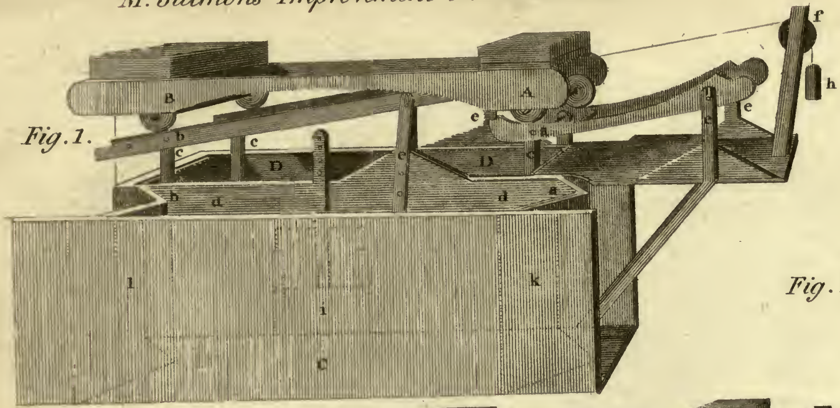
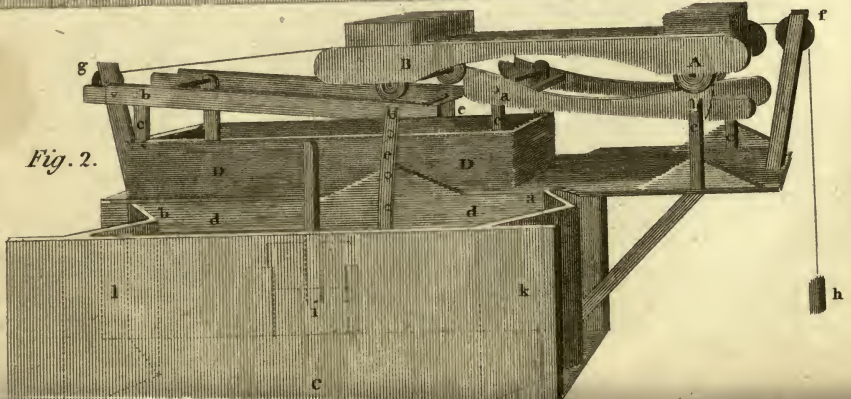


Fig. 2.



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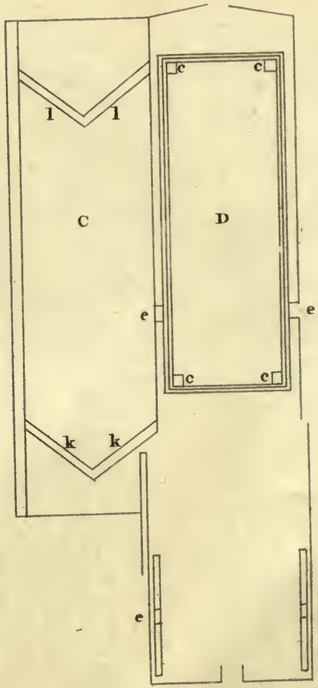

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